Model Engineer

THE MAGAZINE FOR THE MECHANICALLY MINDED

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A WEEKLY COMMENTARY BY VULCAN

IN this week's issue an article appears on the construction of a sawbench and air compressor plant by Ian Steels, one of the younger generation of model engineers, whose activities started at a very early age.

His father, L. S. Steels, was a founder member of the Sutton Model Engineering Club, and a versatile craftsman, who produced among other things an excellent example of the ME cine-projector, and also an improved version of the ME capstan attachment for his lathe, which was put to practical use in the quantity production of radio components during the war.

Ian Steels followed well and truly in his footsteps, one of his first efforts being a Kestrel 5 c.c. two-stroke engine, produced while still at school and used successfully in a model plane of his own design. There is no doubt that his interest in model engineering, and also his proficiency as a craftsman, has helped him considerably in his career, and we commend his example to other youthful enthusiasts who are keen to make headway in the engineering world.

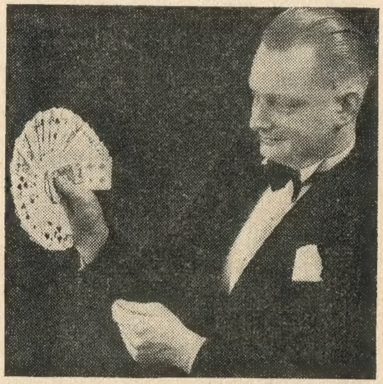
Engineer-conjuror

IT is no news to model engineers that copies of this magazine turn up in odd corners of the world. One dog-eared copy, in fact, was chucking around in one of the outposts of Northern Nigeria during 1943 when it was lighted on by Eric Hawkesworth.

Six years as an engine fitter in the RAF had brought him to the brink of model engineering; the old tattered copy of ME was the final little push that engulfed him in this fascinating hobby.

After the war, in 1946, he launched himself intrepidly into his first model, a $7\frac{1}{4}$ in. *Royal Scot.* The frames for this were laid down in a boxroom with the aid of a 4 in. vice, bolted to a chest of drawers, and a set of hacksaws.

Four years later an almost complete engine was moved to a 10 ft × 10 ft garden workshop for the final stages. It was steamed for the first time on the morning of the terrible



Eric Hawkesworth executing a pretty piece of prestidigitation

Harrow railway disaster. Since then, with the aid of Eric's 72-year-old father, it has steamed over 1,000 miles without failure.

Eric is by profession a conjuror and has appeared in most parts of the country. His ability as a model engineer proves invaluable in his profession, for he invents complicated pieces of apparatus which he describes in the top conjuring magazines.

Hawkesworth, like many other model engineers, is a vintage car enthusiast and he tells me that he has a magnificent example of a 1929 40/50 Rolls-Royce limousine de ville which is almost as good as it was when it left the famous Derby works nearly 30 years ago.

Incidentally, Eric is to marry shortly, and counts himself very fortunate that his wife-to-be can deputise efficiently on the footplate of *Royal Scot*. Lucky man !

An article by Eric Hawkesworth on the maintenance of model locomotives appears on pages 553-554.

Last Star condemned

BRITISH RAILWAYS, Western Region, engine No 4056, *Princess Margaret*, has been, since last January, the sole survivor in service of G. J. Churchward's celebrated four-cylinder 4-6-0 Star class locomotives.

On September 10, this engine was working a fast freight train from Swindon to London, but developed a defect and had to be taken off the train at Southall. She was in a very much run-down condition and was shunted into a siding in the m.p.d. yard, pending examination, and remained there until September 26.

The defect proved to be a burst tube, but some other defects were discovered during the examination, with the result that the engine was condemned. At 1.15 a.m. on September 27 she left Southall on tow for Swindon to be broken up.

The Star class is now extinct except for No 4003, *Lode Star*, which, repainted in the GWR 1907 livery, is preserved at Swindon.

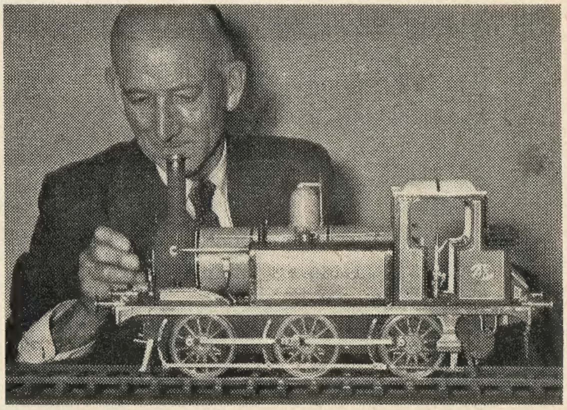
The Brighton Terriers

THE engines of the former London Brighton and South Coast Railway still hold a fascination for the model locomotive enthusiast, and possibly none more than the small six-coupled Terrier tank engines designed and built by Mr William Stroudley from 1872 to 1880.

For the requirements of the railway historian the fullest details have been preserved, but in a less specialised and more popular field these diminutive locomotives have been adopted by artists for reasons as widely separated as inn signs and commercial posters.

The Brighton Terriers were described and illustrated by J. N. Maskelyne in the "Locomotives I Have Known" series in the issue of January 24, and they will form the subject of a lecture which H. V. Steele is to deliver before the SMEE next Saturday afternoon.

The talk will be illustrated by lantern slides of early photographs showing these engines in their original condition, as well as in the state in which those still remaining at work are running. It is hoped to include a photograph of *Brighton* with Mr Stroudley in the foreground wearing a silk hat and kid gloves and carrying an umbrella, the conventional garb of the correctly dressed Victorian engineer !



Ian Steels with a model of a Brighton Terrier

These aspects of the lecture will be mainly introductory, and the principal portion will be devoted to models of this class of locomotive. *Denmark*, the South Kensington Museum example, *Stepney*, built by the Rev. H. T. Brown for R. C. Hammett's collection, and *Leadenhall*, which was on the Society's stand at the recent Model Engineer Exhibition, will be described.

The meeting will be held at the Junior Institution of Engineers, 14 Rochester Road, London, SW1, at 2.30 p.m., and visitors will be welcome.

Duckproof turnstile

BAILEY'S *Useful Inventions for Engineers* was a standard work of reference for engineers for at least forty years until its last edition in 1908. I was reminded of this the other day when the Patricroft (Manchester) firm of Sir W. H. Bailey and Co. celebrated their 125th anniversary with the publication of a useful little book, *A Guide to Valve Practice*.

The book carries engravings taken from the pages of *Useful Inventions* and these include a hydraulic organ blower, a beer raiser and aerator (no doubt responsible for many a creamy head), a bell-chiming machine, and "Bailey's Motophone"—an early warning device for motorists which was operated by bellows or exhaust ". . . the whole blending together into a most beautiful and far-reaching sound that will not irritate the most sensitive person."

Nowadays, as this guide testifies, the firm makes every conceivable type of valve and also specialises in turnstiles (they recently produced a duckproof installation for the National Wild Fowl Trust). But even in the case of an unportable object like a turnstile, they do not produce models for their representatives to carry.

I wonder how many modellers, looking as always for the unusual, would find inspiration in the *Useful Inventions*. During the war a large proportion of their plans and drawings were destroyed by enemy action but if it rests in their power to help any reader who may be intrigued by my remarks, I am sure Baileys will be glad to co-operate.

Cover picture

This miniature class 5 LMS 4-6-0 locomotive was built by Harry Wilkins, of Newport, Mon. This was one of the entries in our recent photographic competition

Further notes on the . . .

AMERICAN TRACTION ENGINE

By Geoffrey K. King

THE Russell Company of Massillon, Ohio, were builders of a very successful traction engine in which they incorporated a number of interesting features.

Fig. 1 shows a general arrangement of one of the later types produced in the 1920s when they standardised in three main sizes having nominal horse powers of 16, 20 and 25, with cylinders 8 in. × 10 in., 8½ in. × 12 in. and 9 in. × 13 in. respectively.

Important dimensions which cannot be scaled from the drawing are width of wheel faces: rear 20 in., front 8 in. and flywheel 12 in., while the width over outside of rear wheels is 8 ft 5⅜ in.

The boiler is shown without lagging, which, though most unusual in Great Britain, appears to have been not so uncommon in parts of America where fuel, particularly wood, was cheap.

The boiler has the water-bottom firebox as used in so many American engines, but the smokebox is rather unusual as it is an iron casting bolted inside to an angle ring riveted to the boiler shell in front of the front tubeplate. This angle ring accounts for the second row of rather widely spaced rivets seen in front of the front tubeplate rivets in the drawing.

The smokebox is a very capacious one, extending well beyond the chimney base, and it should have a very steadying effect on the draught with the minimum of spark throwing.

The engine is side mounted, but the horns carrying the stub axles are braced together by a transverse member which goes down and across the underside of the firebox. The stub axles themselves have a limited up and down movement in the horns, controlled by a short strong helical spring each side. As the pinions of the third motion shaft engage the final gears in a plane nearly at right angles to this movement of the axle, the depth of mesh is only slightly affected.

In my first article I described the type of clutch employed and also the interesting single eccentric valve gear. One of the most interesting points remaining to be dealt with is the very ingenious balanced double-ported slide valve used with this gear.

This valve is shown in Fig. 2, the upper drawing showing a section through the valve, valve chest and part of cylinder, on a plane passing through the axis of the valve spindle, with the valve in the mid-position of its travel; the lower is a diagrammatic view of the valve in its extreme right-hand postion with the left-hand (front) port open to steam and the right-hand (back) port open to exhaust.

In this lower view the valve spindle is displaced and the spring omitted in order to show more clearly the path of the steam. In both views *S* represents the port in the valve face admitting the steam, and *E* represents ports leading to the exhaust pipe.

It will be seen that the steam enters through a port in the centre of the portface and fills the centre and outer cavity of the valve, a well-fitting ring at the back of the valve bearing on the back of the valve chest cover serving the dual purpose of rather more than balancing the upward thrust of the steam and preventing its escape to the valve chest.

A spring between them serves to hold the valve and the ring up to their seats in times of low pressure while

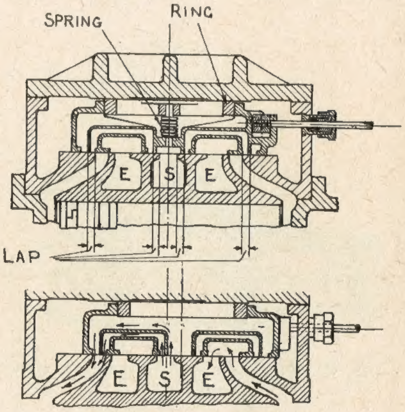


Fig. 2: *Russell ring-balanced double-ported slide valve*

in case of extreme pressure under the valve—due to water—the valve can rise slightly against the spring and relieve the pressure into the valve chest.

Normally there is no pressure in the valve chest and it is a little difficult to know why a stuffing box and gland is provided for the valve spindle. One would have thought a long bush would have been sufficient.

It will be seen that movement of the valve on either side from its mid-position, by the amount of the lap, will bring it to the position where the port on the opposite side is about to open to steam and, as this opening takes place simultaneously at two port edges of the valve, the action is seen to be very rapid, as also is its movement to full-port opening and its quick cut-off. It seems to be a valve with many practical advantages.

One detail which may be noticed in the drawing is the centrifugal oiler

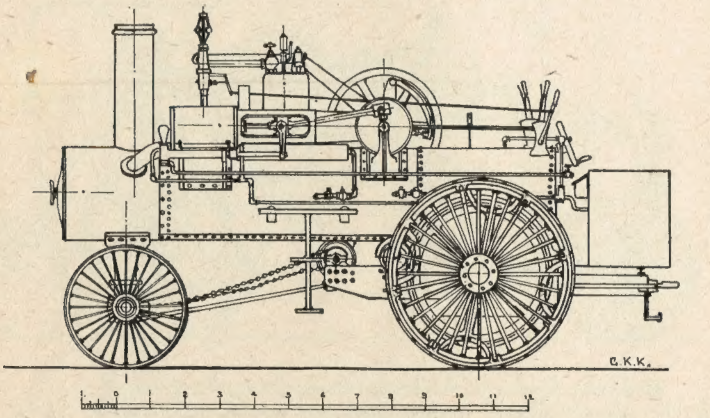


Fig. 1: *Russell* 20 *h.p. engine* 8½ *in. bore* × 12 *in. stroke. Circa* 1923

for the connecting-rod big-end. A radial tube connected to the crankpin at one end and to an oil receptacle on the centre line of the crankshaft at the other rotates with the crankshaft while a lubricator mounted on a bracket in front of the crank-disc feeds oil into this receptacle, from which it passes by centrifugal action up the tube to the crankpin.

The 1923 edition of the Russell catalogue makes no reference to compound engines, but in the earlier years of the century Russell built several models—all, I believe, with tandem cylinders having the low-pressure cylinder in front of the high pressure and completely independent of each other, though with intercepting valve to allow for simple working. Fig. 3 shows a part view of a Russell Compound of 1917.

A popular form of compounding for traction engines in the USA and Canada was that known as the

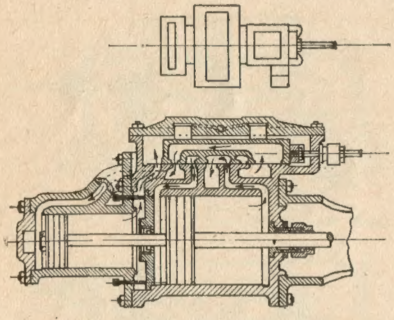


Fig. 4: *Woolf system of tandem compounding*

Woolf pattern. In Britain the term Woolf is generally used to describe any compound without a receiver. This name, by the way, comes from a famous Cornish engineer—Arthur Woolf—who popularised the type in the early nineteenth century.

Although these American engines are, of course, of this type and bear a striking resemblance to certain early Woolf engines, with their closely coupled tandem cylinders and their single valve for both cylinders, the American term seems to denote a proprietary arrangement employed by various makers to convert their standard simple engines to compounds. This would account for the appearance of identical cylinders and valves on the compound engines of different makes, such as Sawyer-Massey, J. I. Case, Port Huron and others.

Most of these compounds were single crank engines so that makers who relied normally on their simple engines, as did J. I. Case and Sawyer-Massey, could with little trouble

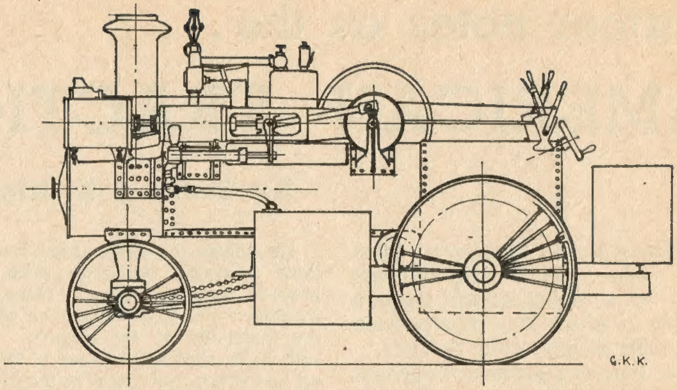


Fig. 3: *Outline arrangement of the Russell tandem compound engine. Details similar to single-cylinder engine. Circa* 1917

cater also for those who desired a compound. The Port Huron Company seem to have taken the matter more seriously and made many two-crank engines with two pairs tandem cylinders on this system.

Fig. 4 shows the arrangement of the cylinders and valve, the h.p. cylinder fitting on to the front of the l.p. cylinder while the single valve controlling both is on the side of the l.p. cylinder.

Steam from the throttle valve enters by the port on the right, passes through the cavity at the back of the valve to the left-hand end where it connects alternately with one or other of the two ports of the h.p. cylinder. The exhaust from the h.p. cylinder escapes by the opposite port to the valve chest and from there passes to one of the ports to the l.p. cylinder while the exhaust from the l.p. cylinder passes out by the other port, under the inner cavity of the valve to the exhaust port and thence to the chimney.

The valve chest is only under pressure from the h.p. exhaust and on light loads this may not be enough to hold the valve on the face. Two small plungers or steam plugs are provided, therefore, in the valve chest cover and live steam can be admitted behind these by means of a small valve and pipe, causing them to press on the back of the valve when necessary.

The front of the l.p. cylinder and the back of the h.p. are separated by a circular division head, held in place by a row of setscrews through the rear flange of the h.p. cylinder. In the centre of this is a simple self-aligning metallic packing which consists of two circles of phosphor bronze cut into three segments each. It is compressed and retained by a stiff steel spring and capped by a per-

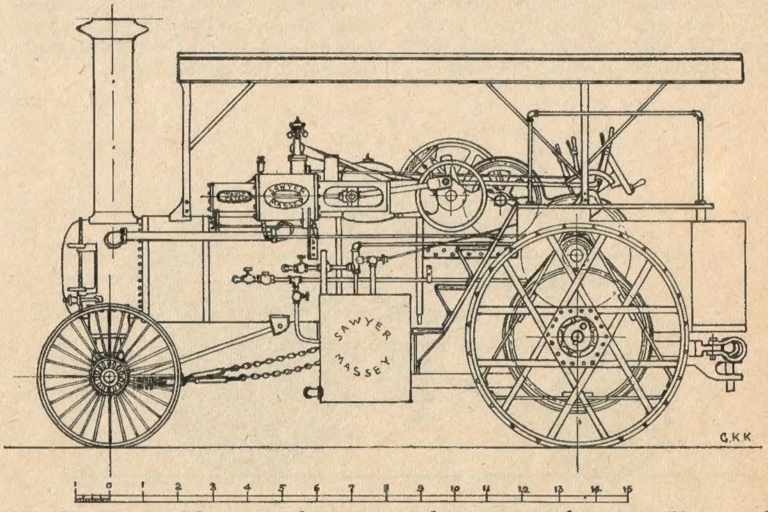


Fig. 5 : *Sawyer-Massey tandem compound rear-mounted engine.* $7\frac{1}{4}$ *in. and* $12\frac{1}{2}$ *in. bore* × 11 *in. stroke, rated* 100 *h.p. Circa* 1914

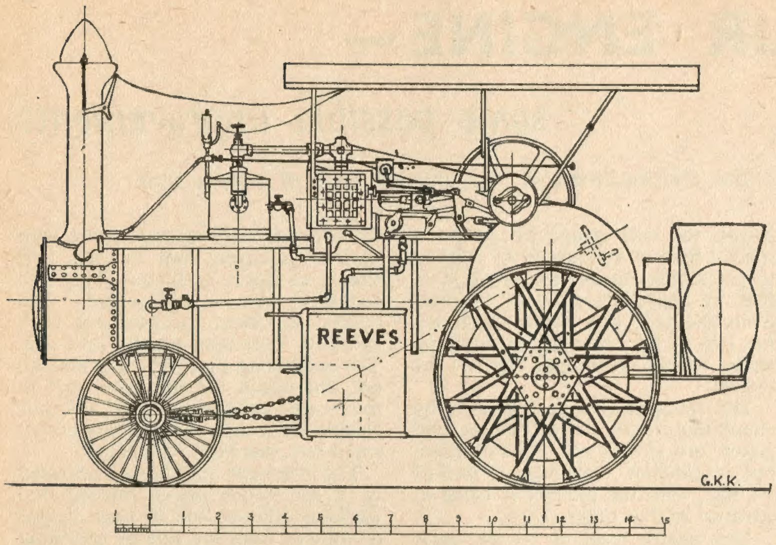


Fig. 6: *Reeves Canadian Special three-shaft rear-mounted engine. Cross-compound* 8½ *in. and* 14 *in. bore* × 14 *in. stroke. Rated* 32 *h.p. Circa* 1916

fectly fitting flat ring and retained in its turn by a flat steel plate secured to the division head by set bolts.

Through this the piston rod passes and the packing is said to maintain a steam-tight seal for a very long time without attention. One rather astonishing thing is that no provision seems to be made for simple working or even for temporary admission of h.p. steam to the l.p. cylinder for starting.

Fig. 5 shows a Sawyer-Massey engine of 100 h.p. with this form of compounding. Beside illustrating this method of compounding, the drawing is of interest as it depicts a rear-mounted engine by this firm.

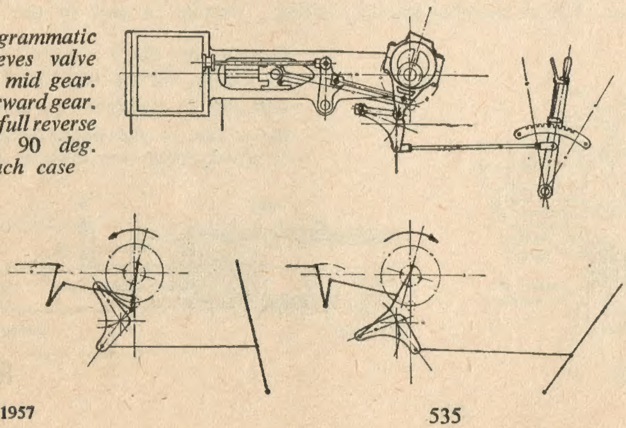
In my first article I showed a drawing of a side-mounted engine by Sawyer-Massey and mentioned that in common with many other American and Canadian firms they produced simultaneously engines with both types of mounting, each having special virtues in the eyes of certain customers.

The outer firebox wrapper plate of the boiler was extended beyond the back plate, and the cannon bearings for the straight-through rear axle and for the third motion shaft carrying the compensating gear were carried in slots in this extension.

The right-hand driving wheel was driven direct from the right-hand side for the compensating gear, the rear axle being keyed to it and turning with it, while the left-hand driver ran free on the axle and was driven from the left-hand side of the compensating gear.

A boss was keyed to the left-hand side of the rear axle outside the left-hand driving wheel with a hole in one side of it through which a pin could be passed, enabling this wheel also to be coupled to the rear axle, so temporarily locking the compensating gear in case of necessity.

Fig. 7: *Diagrammatic view of Reeves valve gear. Right: mid gear. Below: full forward gear. Below, right: full reverse gear. Crank* 90 *deg. down in each case*



The two-cylinder simple engine was almost unknown in Britain after the early nineties, but in America it found considerable favour. A firm that specialised in them was the Reeves company. These engines had, I believe, a very high reputation and their cross compounds were probably the most successful compounds in America.

Fig. 6 represents one of these engines, which shows them to have several features which were decidedly British in their design. It is a rear-mounted engine with a three-shaft drive, and the drive is transmitted from the hub of the wheel through the spokes as in British practice.

The drawing shows flat spoked wheels, but some were provided with a special form of round spoked wheels set at a tangent to the hub and capable of transmitting the torque. The particular type of engine illustrated was known as the Canadian Special and had, among other refinements, completely enclosed gearing, made possible by this type of wheel.

The engine had an intercepting valve for converting it to a two-cylinder simple engine for starting and for emergency use, but the friction clutch usual on American engines is dispensed with. The simpling valve is shown just below and behind the rear cylinder cover. American practice reappears in the water-bottom firebox.

In the Canadian Special engines the cannon bearings for the rear axle and countershaft were mounted in slots in the extended outer firebox plates as in the rear-mounted Sawyer-Massey, but the backplate in this case was flanged outward—a not unusual construction on American engines though very seldom met with in Britain. It certainly made riveting easier. The smokebox follows usual American practice in being formed by an extension of the boiler barrel.

The Canadian Special engines were made in seven different models, four being simple two-cylinder engines and three cross-compounds. The drawing represents the 32 h.p. cross-compound, having cylinders 8½ in. and 14 in. × 14 in. stroke, a flywheel 44 in. dia. × 10½ in. wide, rear wheels 76 in. dia. × 24 in. wide and front wheels 48 in. dia. × 16 in. wide.

All the Reeves engines had what appears to be a very admirable variation of Hackworth's valve gear, to all intents and purposes similar to the gear known in this country as Marshall's gear and employed at one time on small marine engines, the slotted guide of the Woolf and the Woods gears being replaced by a swinging link. It is shown in outline in Fig. 7. ■

THE HOT-AIR ENGINE—

some possible improvements

W. H. PEARCE discusses the technicalities of this unusual type of power unit

The external combustion air engine, to give it its full title, is an obsolete type of prime mover which operates by the alternate heating and cooling of a fixed volume of air in a chamber, the resultant changes in pressure being communicated to a piston in a separate cylinder.

Although this engine has been displaced by steam and internal combustion types it has an appeal to some model makers, on account of its relative simplicity and the absence of a bulky boiler. At the same time, it has no operating valves, and does not require special fuel mixtures for it may be operated by the same solid fuels as a steam engine.

The first engine of this type to be used for power would appear to be that of Stirling in 1861. This was a beam engine which was employed in the Dundee foundry and which ran well for several years. It was double-acting and had two air chambers, in each of which was a hollow plunger, which occupied about four-fifths of the interior space, and was free to move up and down inside to the extent of the remaining fifth.

The contained air was thereby caused to pass alternately from the top to the bottom of each air chamber, and was thus alternately heated and cooled, increasing and diminishing its pressure in the process. The connecting pipe was led to one end of the power cylinder, and that from the other vessel to the opposite end.

For simplicity only one air vessel is shown in the accompanying Fig. 1. *D* is the air vessel, and *A* the hollow plunger, on either side of which is shown the wire gauze which was a special feature introduced by Stirling to economise on the consumption of fuel by absorbing most of the heat from the air as it passed from the hot end to the cold end, giving it up again to the now cold air on its return.

The tubes at *C* were kept cold by circulating water. The plunger and piston are shown at a mid-position, but in practice the phase is one of 90 deg., with the plunger *A* being in advance of the main crank.

This engine used air at 360 p.s.i. The use of compressed air is essential in full-size practice, to increase the economy and also the output, for a given size and weight, but models are satisfactorily operated with the air initially at atmospheric pressure only.

The next attempt was on a smaller scale and was that of Robinson, who put the economising gauze inside the plunger, which was also packed with tubes to pass the air directly through it, the plunger being a closer fit in the air chamber.

His idea was to employ a large diameter plunger and to use the large heating surface provided by the flat bottom of the air vessel. He put the operating piston on top, in a horizontal position, and cooled the top end of the air vessel by an external tank of water.

Fig. 2 will show how the plunger was moved, through the beam *A*, deriving its motion from the small link *B*, which was forked at the end to straddle the main connecting-rod big-end, and both were pivoted to the crankpin.

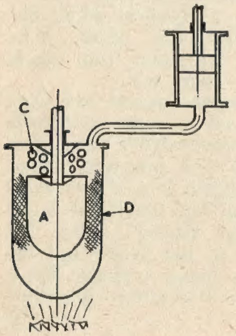
The next step was a very important one. The air chamber and the working cylinder were still separate parts, with their own covers, but in Fig. 3 is shown an engine with equal bore and stroke of plunger and piston. The covers have been discarded and both cylinders have been thrown into one. The connecting pipe, which contained air, but which did not take part in the heating and cooling cycle, and thus constituted a loss, though only a very small one, has been eliminated.

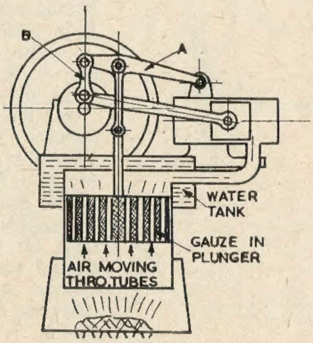
The displacer plunger is operated by a rod which passes through the working cylinder and in turn derives its motion from the side or overhung crank *B*, through the rod *C* and the U-shaped yoke *D*.

It will be apparent that since at one part of the cycle the displacer is at the hot end of the air chamber while the main piston is at approximately mid-stroke, the former is overhung in the chamber to a great extent and the reamed hole in the main piston is subject to great wear and needs to be as long as possible.

In models of this type the displacer soon begins to knock in the chamber, and some positive means of support should be given. This may be by fins for vertical cylinders and by small balls running in grooves for a horizontal one. Perhaps the best solution would be found in a rod or spigot, silver soldered or brazed into the centre of the hot end, passing into a hollow displacer rod and extending far enough down so that its free end was always supported by the forward end of the enclosing plunger rod. (Fig. 4).

Fig. 5 shows another method which might be used—a sleeve carrying the plunger, and operated by a side stub through a slot in the side of the

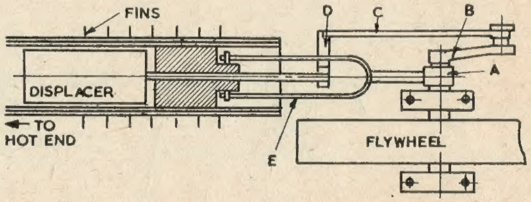


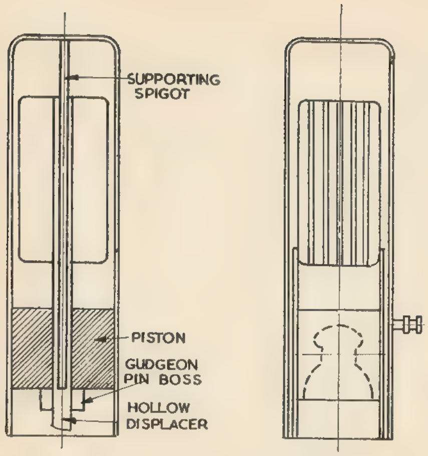


Extreme left, Fig. 1 : *Layout of simple hot-air engine, showing regenerative wire gauze*

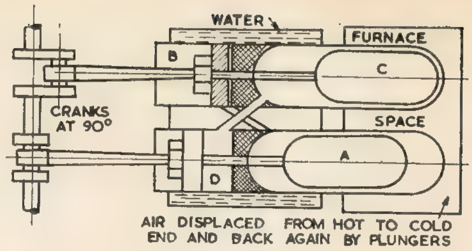
Left, Fig. 2: *Robinson type of hot-air engine*

Below, Fig. 3 : *Showing an important stage in its development—one cylinder instead of two*

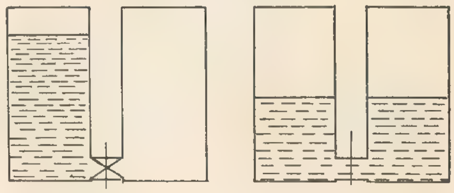




Left, Figs 4 and 5: Methods of supporting the displacer piston



Right, Fig. 6: Principle of the twin-cylinder hot-air engine



Right, Fig. 9: Diagrammatic explanation of the heat exchange

cylinder. In this case it should be noted that the air would have to pass through the plunger directly in tubes as shown, unless the plunger were mounted on cross-fins at the end of the sleeve, so as to leave a space under the plunger.

These tubes would have the regenerative gauze effect, the heat being saved in the tubes at each cycle, and so improving the economy. Also, a normal type of trunk piston could be used, since the centre is unobstructed, and an unforked connecting-rod could be used. If construction is in the form of a horizontal type, these methods of support are most important.

If a vertical design is in question, the working piston would either need to be of the double-acting type with a closed-in lower end, or the crankcase should be airtight, with the object of using the lower side as an air pump to induce a down draught in the fuel, which could rest directly on the cylinder top. In this case the blower air would be led up a tube to a point half-way up the air chamber part of the cylinder, where the combustion gases moving downwards in the annular casing could be collected and ejected through an exhaust stub, by the jet. Of course, a small grid to hold the fuel from descending the casing would be needed at the cylinder head.

If a twin is built you can do away with the extraneous mechanism to work the plunger in each cylinder, provided the cranks are set at 90 deg. to each other. Then the piston and plunger in each cylinder are mounted on the same rod, and the air chambers are put into communication with the pistons of their opposite cylinders (Fig. 6).

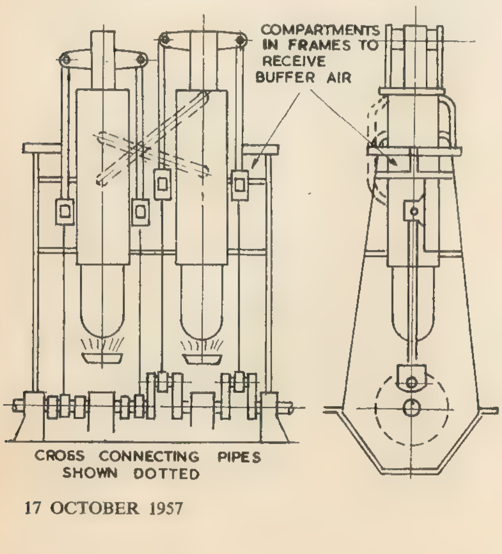
The sketch in Fig. 6, however, is merely illustrative of the first stage in the elimination of extraneous mechanism, and a little study of this will show that as it stands it will not operate. For example, plunger *C* will tend to work piston *D* in the opposite direction of rotation, hence, one crank will oppose the other.

This difficulty can be overcome in two ways. We can arrange to separate the cold end of the chamber with plunger *A* in it, and leave it free from cylinder *D*, and heat this end of the chamber, that is, change them over and alter the point at which the cross connecting pipe enters the chamber to halfway along. The two arrangements now will turn in the same direction. This, however, might be difficult to carry out in practice, involving trouble with the plug between the cylinder and the chamber.

A better solution is by working the front of one cylinder as the power end, while the rear end of the other is still the power end, the opposite sides of the pistons in each case being used as air buffers. To store the buffer air, either a clearance space would be needed in each "free" end, making the whole cylinder longer, or space must be made in the frames.

Fig. 7 shows a suggested method of providing for circulation of cooling water round the top end of the chamber and through the separating plug.

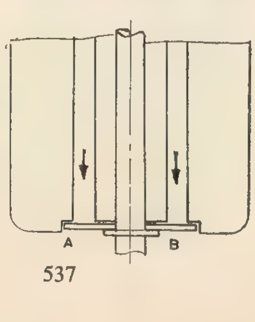
A vertical engine with the air

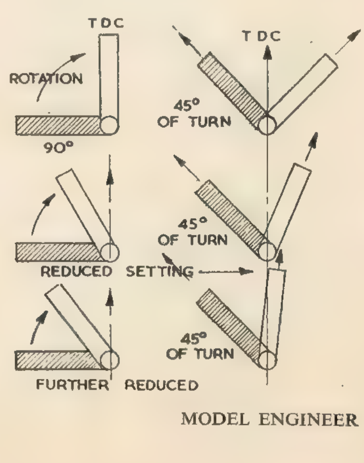


Left, Fig. 8: Design for reducing excessive height of an engine

Right, Fig 11: The effect of retarding the plunger in relation to the piston

Below, Fig. 10: The location of the disc on the plunger rod





chambers uppermost would make a rather tall engine and to reduce the height the design shown in Fig. 8 could be adopted, with two side rods and a cross beam to each cylinder.

One of the laws of thermodynamics says that heat can only flow from a high temperature to a low one, unless, of course, it is "pumped up the hill," as in a refrigerator, by using power. In a steam boiler, the water always remains at a temperature substantially below that of the furnace, so that a large proportion of the heat in the combustion gases is transferred to the working fluid (steam) and the boiler efficiency is, therefore, fairly high. But the hot-air engine stands, in this respect, at a disadvantage as can be demonstrated.

In Fig. 9, on the left, are two vessels of equal capacity, one full of fluid and the other empty, but they are interconnected by a short pipe provided with a valve, which is closed. If it is opened, the fluid in the left-hand vessel will flow into the right-hand vessel until a state of equilibrium is reached. This, simply demonstrated, is what theoretically happens in an air engine.

The vessel on the left represents a given weight of combustion or furnace gas containing a quantity of heat, represented by the volume of the fluid, and the vessel on the right represents the same weight of cold air in the air chamber of the engine.

Our experiment shows that half the heat in the furnace gas is absorbed by the air in the chamber and the other half remains behind in the furnace gas because the temperature of that is no longer superior to that of the air in the chamber. The final temperature of the air should reach, theoretically, half that of the furnace gases, but this efficiency is not reached in practice. A good guess is one-third.

How near is this guess to actuality? In the internal combustion engine, with which we are all so familiar, all the heat developed by combustion enters the working fluid, and were it not for the fact that the theoretical rise in pressure (five times the compression pressure) cannot be reached in practice (because the products of combustion reach their dissociation temperature when the maximum pressure reaches only 3.6 times the compression pressure and, therefore, further heat production is brought to an end) its power and efficiency would, in practice, be much greater.

Part of the loss can be attributed to what is absorbed by the coolant but since it first has to pass into the working fluid of the engine, our theoretical figure of five times can be considered a safe one for the demonstration, since the hot-air engine also suffers radiation and similar losses. That absorbed by the coolant is not a loss, from the point of view that it is the "heat sink" necessary to operate the engine. (These considerations do not take account of the effect of regenerative gauze or plunger tubes.)

This ratio of five times means that in the i.c. engine, to every unit of compression there is added another four. If this is divided by our guess of one-third for the boiler efficiency of the hot-air engine, it should give the amount to be added on heating the air in that engine, so that 1 1/3 is our answer.

Engines working at atmospheric pressure indicate a maximum pressure of 20 p.s.i., which is 20/15 = 1 1/3 atmosphere, which agrees exactly with the assessed result above.

Since two-thirds of the heat goes to waste, it might be possible to use some of this to heat a second cylinder, and we could recover 2/3 × 1/3 = 2/9 more, of the heat of the furnace, raising our boiler efficiency from 33 per cent to (1/3 or 3/9 + 2/9 = 5/9) 55.5 per cent. So the second cylinder would produce 2/3 of the power of the first.

So far we have considered only the boiler efficiency—the percentage of the total heat of combustion which the engine absorbs. We can calculate the thermal efficiency, by comparing it with the internal combustion engine as we did with the boiler efficiency.

The boiler efficiency (theoretical) is 100 per cent for the i.c., 50 per cent for the e.c. engine, but in practice we find the i.c. engine can effectively use only $\frac{3.6}{5.0} = 72$ per cent of the absorbed heat. For one unit of compression pressure it adds 3.6 − 1 = 2.6, and the hot-air engine (e.c.) 2.3 − 1 = 1.3, which figures agree exactly with the theoretical boiler efficiencies, since:

$\frac{0.50}{1.00} = \frac{1.3}{2.6} = \frac{1}{2}$ or 50 per cent, which is the thermal efficiency we can expect from hot-air engine in relation to an i.c. engine operating with equal compression.

This, of course, is altered when we consider the possibility of recovery of a part of the heat which escapes unabsorbed, by directing it on to another cylinder. In this case, as previously shown, we can use 2/3 or 66 2/3 per cent more, so that our efficiency can be improved, rising to 1 2/3 or 5/3 × ½ = 5/6 = 83 per cent of that of an equivalent i.c. engine.

PLUNGER TUBES

Apart from considerations of regeneration, or economy of the heat within the air vessel, there is another point that may brought to notice.

As the plunger moves and sends the displaced air into the hot end, the air, in increasing its pressure tends to expand and set up a counter current, to that of the air passing round the plunger to the hot end; therefore, to permit a counter current of heated air to the passage, or pipe, connecting with the power cylinder, tubes should be inserted near to the central axis of the plunger; even if they are not inserted all over, for regeneration.

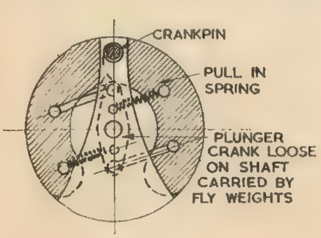
It will be apparent that something is needed to ensure that the air takes its first path round the plunger and

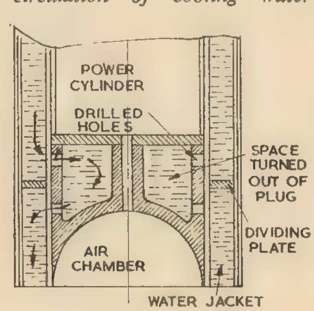
●*Continued on page 560*

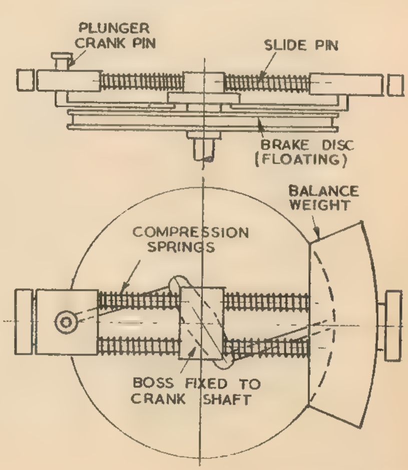
Right, Fig. 13: *One method of reducing the plunger stroke*

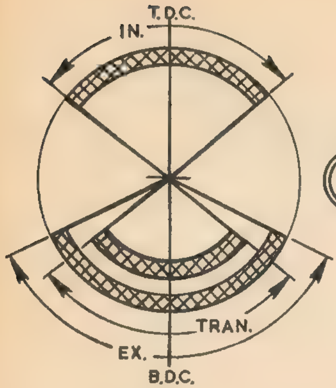
Left, Fig. 12: *Using flyweights to reduce the plunger stroke*

Below, Fig. 7: *Providing for circulation of cooling water*









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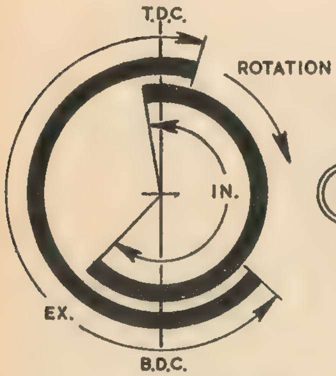

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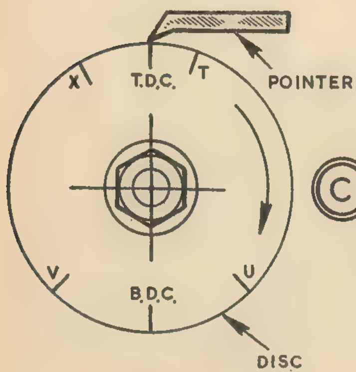

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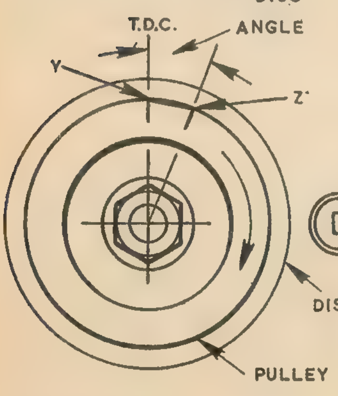


D

Beginner's Workshop

By GEOMETER

PORT and VALVE TIMING

WHETHER an internal combustion engine is model or "full scale," its running is controlled by the sequence of port openings (if it is a two-stroke) or by valve events if a four-stroke. For timing, these port and valve events are always given in relation to two fixed points in piston movement—when it is farthest into the cylinder at top dead centre, and when it is farthest out of the cylinder at bottom dead centre.

In the case of a simple two-stroke engine timing only really concerns the designer, tuner or student. It is of little interest to a mechanic, since it results automatically from assembling the engine.

In the case of a four-stroke engine of poppet valve type timing is necessarily of interest to the mechanic, since it is essential for it to be correct on assembly, and there are a number of possibilities. It may be known from a handbook or data, or may be checked before the engine is dismantled.

It may derive from a single camshaft, as on most cars and some motor cycles, or it may result from two camshafts operating inlet and exhaust valves. For a mechanic dismantling, it is desirable to know the number of camshafts and timing—the complete timing if there are two camshafts.

Examples of four-stroke timing are:

1 Inlet opens at t.d.c.; closes 45 deg. after b.d.c. Exhaust opens 50 deg. before b.d.c.; closes 10 deg. after t.d.c. With a single camshaft, setting of inlet controls the timing; with two camshafts, separate setting required for the exhaust.

2 Inlet opens 10 deg. before t.d.c.; closes 50 deg. after b.d.c. Exhaust opens 50 deg. before b.d.c.; closes 10 deg. after t.d.c. Timing is equally overlapped at t.d.c., and with a single camshaft can be easily checked against piston movement.

3 Inlet opens 5 deg. before t.d.c.; closes 45 deg. after b.d.c. Exhaust opens 50 deg. before b.d.c.; closes 15 deg. after t.d.c. Timing is not equally overlapped, nor does inlet open at t.d.c., so there could be confusion with *1* and *2*, if not known.

In some instances timing for *3* may be obtained by setting the inlet valve with a wider clearance to open at t.d.c. Almost always, the same could be done for the exhaust—i.e. chose the t.d.c., open the adjustments until the valves are just seating, then turn the engine and check clearances with feeler gauges before dismantling. Then, on assembly, verification is possible.

Points of valve opening and closing may also be given or obtained as distances from t.d.c. of the piston which can be measured in the cylinder. Again, motor-cycle engines with internal flywheels can have dot marks made on these against a reference dot in the crankcase.

A cardboard disc on the crankshaft, a fixed pointer on case, and observing where the piston of a simple two-stroke engine uncovers and covers the ports, a diagram is obtained as *A*, the timing equally overlapped, and the exhaust enclosing a larger angle than transfer owing to greater depth of ports.

Representation of four-stroke timing is as *B*, where inlet-exhaust timing is not equally overlapped at t.d.c.—case *3*. With the cardboard disc and pointer, this timing is obtained as *C*. Point of inlet opening is *T*, point of closing *U*. Point of exhaust opening is *V*, point of closing *X*, t.d.c. and b.d.c. being marked. Such a disc can also be set out with a protractor (draughtman's type), or the angles obtained can be measured.

For checking car timing, the inlet opening angle can be marked on a disc, as *D*. The crankshaft pulley diameter is marked and the angle obtained as a straight line between *Y*, *Z*. Dividers transfer this to the actual pulley, nicking with a file to check to a pointer. ▣

WORKSHOP TOPICS

A Martin Cleeve miscellany

From Jacobs chucks to power hacksaws and cranes . . . this is the kind of field our contributor covers in this feature

CONSIDERABLE time has passed since I was last able to write one of my Topics but, at least, EW lathe owners will know that I have not been exactly idle.

The last time I had occasion to dismember and clean a Jacobs chuck, I took the opportunity of making a picture of the pieces (Fig. 1). The question of how to take one of these chucks to pieces is one which is often raised by readers, and each time the subject is mentioned I recall what struck me as a highly amusing little story.

But first, for the benefit of those who still do not know how to strip one of these chucks:

1 Bring the tips of the jaws flush with the mouth of the body;

2 Looking at Fig. 1, the outer bevel gear ring and case at the left must be made to pass upwards over the inner body at the right, so stand the taper adapter end of the chuck on a piece of tube or pipe having a bore of such a size that the *body* will pass through but the gear ring and case will not.

Now, if the bench vice can be opened far enough to accommodate this assembly, a gentle tightening of the jaws will push the gear ring over the chuck jaw end of the body, after which the inner components can be removed easily.

Should the vice not be large enough for the job, the body may be knocked out with a mallet, but, of course, care must be taken not to give blows any heavier than absolutely necessary to do the work.

If it is desired to remove the taper adapter (Fig. 1) rear centre, it will be found that the easiest way is to drill a hole, say $\frac{1}{4}$ in. clearing, through the chuck body; the taper may then be knocked out with a punch.

Now the story.

I owe this to a friend of mine who worked his way up through various factories from centre-lathe turner to a top executive position with a large engineering group.

He told me how, during his shop days, a man would decide that his chuck was in need of a clean up. On taking it to pieces, of course, the split screwed ring (Fig. 1 bottom left) would fall out, as like as not the two halves dropping to the floor. Revelation! " Oh, no wonder it was stiff and not working properly: the ring's broken ! "

Whereupon, having every facility for repairs, the full resources of the firm would be swung into action and a considerable amount of time spent in the preparation of a new one. Thread form and angle of taper were carefully set, checked and re-checked; best quality steel given superfine heat treatment—in fact the copy is going to form an example of the highest form of craftsmanship.

And then—embarrassment ! The new ring cannot be fitted until it has been " broken " in eactly the same way as the original.

Actually, the manufacturers do fracture the ring. A saw cut would not serve because, in assembly, the outer housing must grip the two halves with a frictional interference sufficient to cause the ring to rotate to operate the chuck jaws.

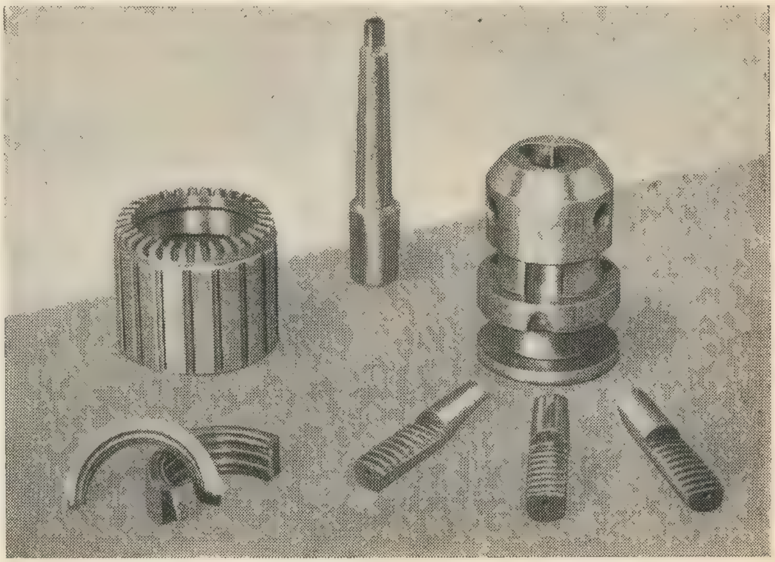


Fig. 1: The component parts of a Jacobs chuck

IT'S GOT COLLETS !

By the way, if it is desired to make an adapter for one of these chucks the taper in the body, in the case of the 0-$\frac{1}{2}$ in. size, is a short No 2 Morse. I did not discover this until comparatively recently, and when I had occasion to make one some years ago I spent considerable extra time in adjusting the topslide and chalk-

mark testing what was thought to be a special taper !

Writing of chucks reminds me of the collet type. I often wonder why it is that model engineers seem to attribute some magical powers to these and to think that the mere possession of a set will guarantee a short cut to the last degree of accuracy in lathe work.

I have known people to buy the most revolting assembly of rusty, chipped and worn out junk, labelled LATHE, just because there happened to be a set of collets with it—the assumption doubtless being that the collets would fully compensate for the disgraceful condition of the rest of the machine.

It is my own opinion that the production of accurate work, while being dependent to a certain extent upon the condition of the lathe, rests chiefly with the skill and knowledge of the operator.

Collets are expensive and a large number is required to cover a useful range of sizes. For the amateur who has to carefully plan his expenditure on tools and equipment, a dial indicator or "clock" as it is sometimes called, would be found to be a much more useful aid to precision work. These can be bought at prices ranging from as little as 7s. 6d. for the very reliable Unique type, up to many pounds for the more pretentious and elaborate kind reading in tenths of a thou.

There are so few jobs which call for collet chucking that I have managed up to now without them. It must, indeed, be a strange component which cannot be gripped with truth in a four-jaw chuck—or a three jaw self-centring without the back-plate register. Of course, the accurate setting of an independent chuck takes time, but is this of such importance to the amateur who usually only requires one or two components ?

Collets are used in industry where rapid working is essential, but here again there is a difference: a collet, once satisfactorily set, remains in use until either it is worn out or the end of a particular production run is reached.

BUILT-UP MACHINE VICES

Readers may remember my description of a fabricated vice for the drilling machine [MODEL ENGINEER, 19 April 1956] but until now I have not had occasion to mention that the construction of the first proved to be so fascinating that a second one was made (Fig. 2).

Just because the commercially made article would doubtless have a square thread screw, so accordingly did my prototype. But, as in my description it was suggested that a V-thread would also serve for those without facilities for square thread cutting, in making the second I took the opportunity of providing it with a V-thread, actually a $\frac{5}{16}$ in. Whit.—this having 12 t.p.i.

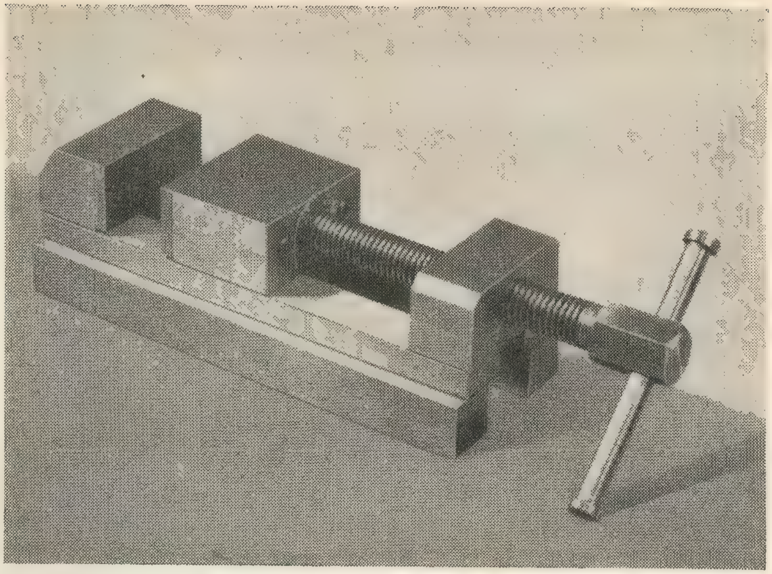


Fig. 2: Hexagon socket capscrews are ideal for the fabrication of this kind of tool

As anticipated, this proved to be fully satisfactory and, as a matter of fact, this vice receives exclusive use and often appears in my illustrations of drilling operations.

The dimensions of this new vice are, apart from the screw, exactly the same as the original: width of jaws $2\frac{1}{16}$ in., depth 1 in., opening to $3\frac{1}{16}$ in.

As a further point of interest I should like to mention that while high-tensile hexagon socket head capscrews were recommended for fixing the various components together in the original, the vice here depicted is screwed together with home-produced hexagon socket screws made from ordinary bright mild steel bar.

As commercially made socket screws have a tensile strength of over three times those of mild steel, any lingering doubts as to practicability can be set aside.

BENCH VICES

The subject of vices reminds me of the question of the hard serrated jaws fitted to bench vices and what a confounded nuisance they can be. These vices, although undoubtedly of enormous use are, in general, such uninteresting tools that they are apt to be accepted and used without question.

Now it is a well-known fact that, in order to avoid marking the work, users are advised to interpose various soft packings. I have even seen detailed instructions for making a mould in which to cast sets of lead clams—anything, in fact, except the obvious, that is for the manufacturers to fit soft mild steel jaws in the first place, leaving the nutmeg grater type as optional for the few remaining blacksmiths left today.

I used to use two pieces of brass angle and spent more time retrieving them from the floor than in actually using them to grip work. After tolerating this idiotic state of affairs for many years I suddenly realised the stupidity of it, made a set of mild-steel jaw pads and threw the hard set in the dustbin—an action which I have never regretted.

While making the change I also arranged for the new m.s. pads to be fixed with hex. socket screws: almost everyone will be familiar with the difficulty of tightening the screwdriver type normally fitted.

I have a friend who is also a mild-steel jaw convert, and when he calls he sometimes runs his finger along my vice jaws and remarks with delightful facetiousness, "Dear me ! These *are* getting smooth; it's nearly time we had a new set, isn't it ?"

POWER HACKSAW

Some readers may remember my query regarding the strange geometric markings which appeared on a piece of sawn 5 in. dia. mild steel. Actually the picture was taken from the centre of the photograph reproduced here (Fig. 3) which shows my power saw as it is today.

A MARTIN CLEEVE MISCELLANY

At the time of purchase, this was arranged for flat-belt drive from a motor of half horse power, but as short flat belts are seldom fully satisfactory I borrowed a friend's lathe and put V-grooves for ½ in. V-belts in the crank pulley, added a countershaft beneath the vice and so obtained a reasonable double reduction from the motor—a Brooks Cub with intermittent rating. Incidentally, this saw was bought second-hand but there is no sign of a maker's name on it. I wonder if any reader can recognise it?

I added the switch—one of those simple but highly irritating jobs which took up far more time than would seem credible. I also thought that a handle would be useful to obviate holding the moving frame when lowering it on the work, but in making this I wasted my time as the continual change in position of the heavy saw frame prevents steady control.

However, the machining of the long taper for the handle proved interesting as it was done by slowly feeding in the cross slide by hand while the saddle moved under self-act; a good method for relatively unimportant tapers.

CRANES

While model enthusiasts are very keen on steam locomotives, ships, clocks, stationary steam, petrol and gas engines, cranes are neglected. Is this because constructional details are not given by those who have built one, or is it that cranes are thought to be uninteresting machines with such limited scope that the matter is not considered worth even looking into?

Of course, I am not talking of the type of crane wherein each movement is carried out by means of a separate hand crank; the kind I have in mind must be power-operated throughout and be controlled from a centralised group of levers. It is my opinion that much interest is to be derived from the design and assembly of suitable gearing, winding drums, vari-speed control . . . in fact, arranging things so that the mechanism responds to the controls as promptly and as smoothly as possible.

Many of the larger cranes utilise a separate electric motor for each movement—load hoist, luffing and swivelling, for example. But while this would offer a comparatively simple solution to the control question, the expense of three or more direct current, variable speed and reversible electric motors together with a transformer and rectifier to supply them, would hardly be justified for a model except in those few instances where manufacturers order an exact scale replica for advertisement or instructional purposes.

Moreover, the motorising of each movement would eliminate the attractive possibilities for the assembly of ingenious mechanical arrangements and, though the crane would doubtless be fascinating to operate, its construction would not be interesting.

The alternative, therefore, is to use one electric motor—steam or other engine—and to pick off all movements through reversible gearing, etc. It is at this point that I think prospective builders lose heart. Far too many gears and components would be required to find the best combinations by direct experiment and, on the other hand, the element of uncertainty inherent in theoretical planning is distasteful to those with an urge to get on with the practical side in the workshop.

However, through assembling a crane for my young son I happen to be in a position to offer a little practical advice on these matters and, if these notes do not bring forth howls of protest from readers or a stern letter from the editor, I shall be pleased to do so, though I must warn readers not to expect a handsome scale model.

The dressings must be left to those with more time at their disposal. ▣

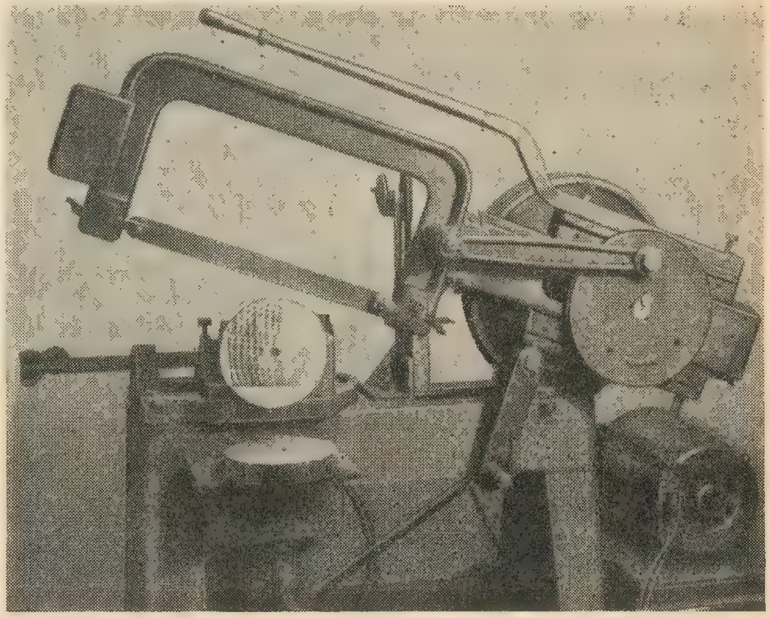


Fig. 3: The author's power saw. Can you recognise the make?

DOUBLE-DRAUGHTING BR ENGINES

INVESTIGATIONS have been carried out by British Railways into the application of double-draughting arrangements (double blast-pipes and double chimney) to one of the BR standard class 4 mixed traffic 4-6-0 tender locomotives, No 75029.

Service tests with this modified locomotive were undertaken with particular regard to the lower grade fuel likely to become available in the future, and revealed that it was capable, with Blidworth grade 2B coal, of fully maintaining a steaming rate of 22,500 lb./hr under all reasonable service conditions over a route with rising gradients of approximately 1 in 50.

This represents more than a 50 per cent increase over the nominal rate for the class 4 engine (14,000 lb./hr).

It is proposed, therefore, to fit all 80 locomotives (Nos 75000-75079) of this class with the double-draughting arrangements.

A WORKING MODEL OF
ST NINIAN

By EDWARD BOWNESS

Continued from 3 October 1957, pages 472 to 474

Part 21—With this instalment the series comes to a close. All that remain are the heating and ventilation installation, the rudder, flags and the painting of the model

Pleno unit and exhaust fans as seen from forward

ONE of the most conspicuous features of the wheelhouse top is the Pleno heating and ventilating unit, with its attendant exhaust fans and their discharge pipes. Through the courtesy of the manufacturers, Winsor Engineering Marine Ltd, of Glasgow, who have supplied me with drawings and details, I am able to describe these fully and accurately, thus adding a modern and interesting feature to the model.

The Pleno unit, which is the central feature of the installation, consists of a casing which contains a steam heater with valves for regulating the amount of heat and the degree of humidity in the air delivered. It is surmounted by a centrifugal fan and the motor which drives it, the air to the fan being drawn through an inverted trunk or, as on *St Ninian*, an air filter on its inlet side.

In the installation on *St Ninian* the heated air is discharged on each side of the casing and led through curved ducts to a rectangular casing with a sloping top which is shown in the heading picture and in my drawing (Fig. 102). The air passes from this casing—to be taken by means of trunking—to any desired point about the ship. Cold air can be circulated if desired by means of a duct which bypasses the heater and leads direct by way of the casing to the trunking below.

There are two similar but smaller Pleno units in the fan room, in the base of the funnel for serving the accommodation further aft, but as these are not an external feature of the vessel I have not concerned you with them in the model. The louvres in the sides of the funnel, referred to on page 844 (June 13), are for the air supply to these units. The only external feature of this plant is the exhaust fan (Fig. 103) which is located on the boatdeck and which, being partly hidden by the seats and the big water tank, may or may not be included.

Of the two exhaust fans on the wheelhouse top the larger one draws air from below through the casing of the large Pleno unit, as will be seen in the illustration and in Fig. 102. The smaller one draws air from a duct on the centre line of the ship which comes up from the first class dining saloon on the promenade deck below.

The square discharge cowls from these two exhaust fans with their enlarged tops are very conspicuous, and with the air filter pipe on the unit itself rise to almost the height of the funnel and form quite a feature of the profile of the ship.

MODELLING THE INSTALLATION

Coming now to the actual model, these parts could be fabricated in tinplate or they could be carved in a close-grained hardwood, such as lime or sycamore, or even in boxwood. Some modellers prefer to work in metal, others in wood, and it is better for each to follow his own natural bent. Personally, I think it would be very finicky work to make them in metal except, perhaps, the electric motors. These could be turned in brass and the feet and ring added separately.

In the Pleno unit itself the air-filter inlet pipe is supported on an angle framing as shown in the drawing and in the picture on page 845 (June 13). This could well be made in tinplate even though the remainder was made in wood.

The six air inlets are open at the bottom; the fan discharges downward to the heater but the branch on its forward side is quite conspicuous and should certainly be shown. This bypasses the heater and, when in action, delivers cool air to the trunking system. The hot air discharge pipes come out on each side and curve upward and down into the sloping top of the rectangular casing.

A 12 in. mushroom ventilator comes up from below through the casing. This and the other details referred to are shown clearly in my picture. The piping from the 100-gallon water tank may also be seen, but I ignored this when describing the tank as being an unnecessary complication.

Details of the two exhaust fans with their ducts and discharge cowls are also shown in the picture, and from this and the drawings there should be no difficulty in modelling these parts.

MISCELLANEOUS ITEMS

There are still a few items on the wheelhouse top which I have not yet mentioned. These include two or three battery boxes. The builder's plan shows two whereas the picture on page 844 (June 13) shows three. They are approximately 3 ft square and 1 ft 6 in. high.

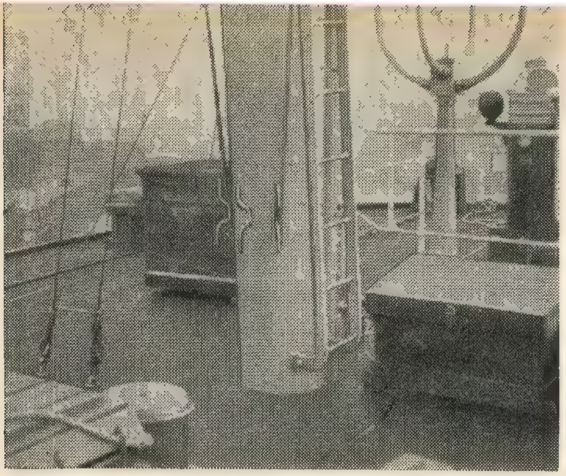
Their general appearance is shown in the illustration on page 545 which also includes other interesting details.

The casing to the port and forward of the mast is for the storage of rockets, and measures approximately 2 ft × 3 ft × 2 ft 6 in. high. Another case is seen behind it. This apparently is for the Pyrene fan, but unfortunately I have no information about its construction. A portion of one of the life rafts described in part 20 is to be seen in the lower left-hand corner of the picture.

One of the cargo lights may be seen at the port corner of the upper bridge. This is on a swivel mounting. In the picture it is obscured by the pillar of the direction finder, but in the left-hand picture on page 630 (May 2) it is shown more clearly.

There are two additional cargo lights aft, these being located on the rail at the after end of the promenade deck, one on each corner, port and starboard. One of them may be seen in the picture on page 582 (April 18) being only just discernible against the mouth of the cowl behind it. Yet another swivelling light may be seen in this picture mounted on a pillar just forward of the foremost lifeboat.

The illustration on page 630, already referred to, shows also the searchlight. This is on the starboard corner of the upper bridge, and owing to its conspicuous position should certainly be included, especially if it is intended to light up the model. It is of the



Left: *Base of the foremast looking toward upper bridge*

Below, *Fig.* 102: *The Pleno unit and exhaust fans on wheelhouse top shown actual size for model*

orthodox pattern and the glass would appear to be about 16 in. dia. In the model this would be a shade over ¼ in. Another view of the searchlight —this time with a canvas cover on it— is to be seen in the picture on page 844 (June 13).

A hand reel for coiling wire rope will be seen in the lower picture (page 473, October 3). A similar reel is to be found on the starboard side (see page 505, April 4), and another toward the forward end of the docking bridge.

Yet another is to be found on the forward shelter deck (see lower right-hand corner of the illustration on page 934, June 27). They are not difficult to make and add to the realism of the model.

One of the life rafts may be seen on page 273 (August 22). The dimensions and further details are given in Fig. 100.

They are similar to the lower portion of the double buoyancy seats and may be made in the same way. They are evidently interchangeable and all the sections would appear to have the locating strips shown in the drawing.

Incidentally, one or more of these rafts could be used as a marker buoy if the model should unfortunately sink during operations. All that is needed is to attach a line to the underside of the lower section and to the deck underneath it, coiling it on the deck under the raft, where it would be invisible.

It is, of course, assumed that during operations the superstructure would be secured to the hull in a similar manner to that for the docking bridge, as explained in part 19. Four sets of life rafts are required, all of them being placed on the wheelhouse top (Fig. 90).

The lifebelt lockers are approximately 7 ft long, 3 ft wide and 2 ft high. Fig. 101 shows them in front elevation. Their general appearance may be taken from the picture in the issue of October 3, which shows also the way they are lashed down to the deck.

In the plan I have shown eight in all, located as follows: three on the docking bridge, three on the boat deck—one aft of the large water tank and the other two just forward of Boats 5 and 6—and the remaining two on the wheelhouse top.

MAKING THE RUDDER

So far I have made no mention of the rudder. It may require modification after the boat has been tried out, and its proportions may be affected if the model is fitted with radio control. But for a start I suggest you make it a scale copy of the original. This would make it 1.4 in. wide from the centre of the rudder post to its after edge. The depth between the faces of the two bosses in which it swings

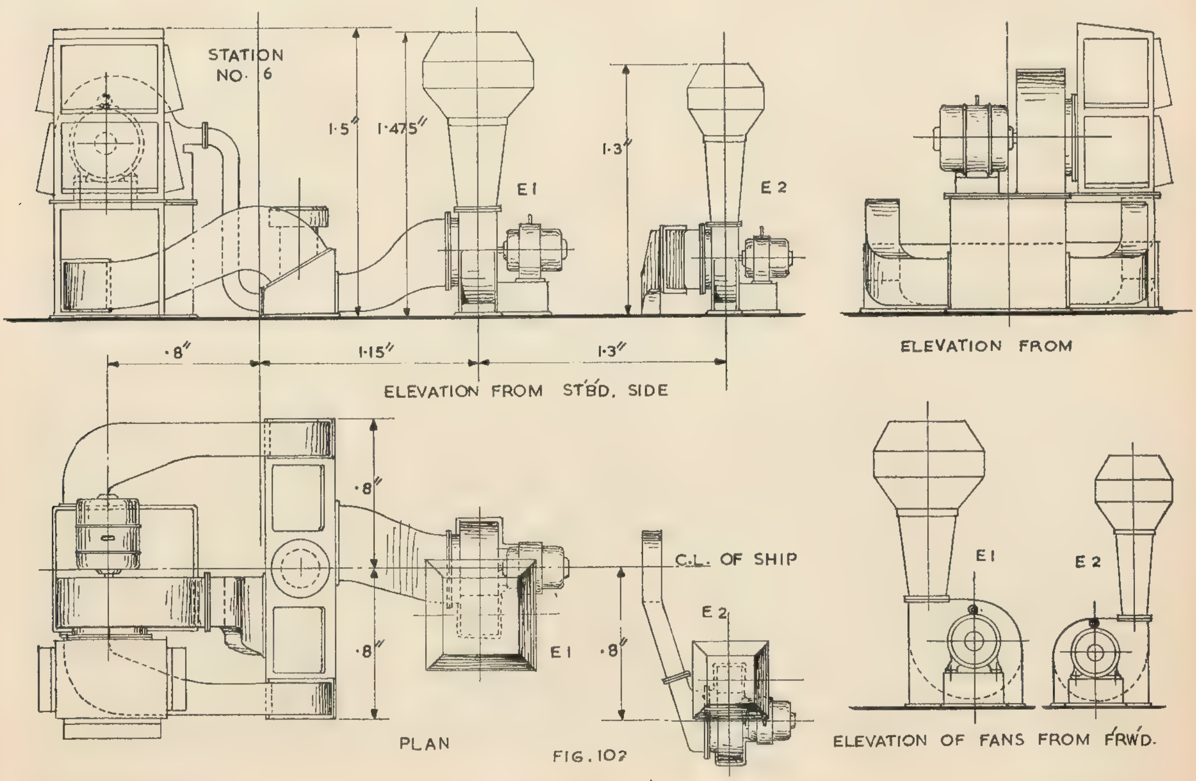


FIG. 102

is 2.3 in. and it should be an easy fit between these.

The rudder post is made from $\frac{1}{8}$ in. dia. mild steel and the blade of the rudder from 20 s.w.g. sheet brass. The sheet is cut to the shape shown in Fig. 104, wrapped closely around the steel rudder stock and the after edges soldered together. An allowance is left on the upper and lower edges as shown in the drawing, and these are flanged over until the edges meet, when they must be soldered together.

The upper and lower faces of the sheet where it encircles the pin are then filed truly flat until the blade of the rudder is an easy fit between the bosses in the sternpost of the hull.

The pin or rudder stock, which is $5\frac{1}{2}$ in. long, should then be threaded through the blade and the assembly inserted in the vice so that it is gripped about 1/32 in. below the centre line of the stock, as shown at *A* in Fig. 104, to ensure that the stock is close up against the inner surface of the blade. The stock should project 0.2 in. below the lower edge of the rudder.

Two holes, 1/32 in. dia., should then be drilled through both blade and stock so that later, when it is assembled in the hull, rivets, which are of 20 s.w.g. brass wire, can be driven through and the ends lightly burred over.

The rudder should not be fitted finally in position until the tiller is ready for fitting, which will be after the steering arrangements are finalised.

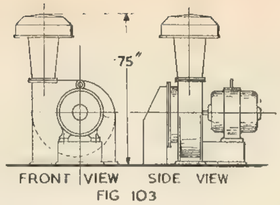
THE FLAGS

Many ship modellers avoid the use of flags as there are many pitfalls, but used sparingly and correctly they can be a great asset and will add that touch of colour which gives brightness and smartness to what may otherwise be a rather dull model. Not to overdo it I suggest you fly the owners' house flag at the mainmast head, the red ensign on the ensign staff aft, and the pilot jack at the stem head.

The house flag of the owners, the North of Scotland and Orkney and Shetland Steam Navigation Co. Ltd —to give them their full name—is coloured blue with a horizontal white band along the centre, the three divisions, blue, white and blue, being equal in width. In the model the flag should be about $\frac{3}{4}$ in. deep by about $1\frac{1}{8}$ in. long. The red ensign should be about 1 in. deep × 2 in. long.

The pilot jack is the Union flag with a white border 1/5 the width of the flag itself. In the model it should be $\frac{1}{2}$ in. deep × 1 in. long; sometimes it is made somewhat shorter.

For further information the builder is recommended to study the book *Flags for Ship Modellers and Marine Artists* by A. A. Purves, published by Percival Marshall.



The exhaust fan on the boatdeck

PAINTING THE MODEL

The hull of the model should be painted black down to the water line. This is a white line $\frac{1}{8}$ in. wide. It should be raised slightly towards the bow and stern as shown in the general arrangement drawing on pages 96-7 (January 17) as this avoids the drooping effect produced if it is drawn dead level.

Below the water line the hull is painted red, the usual anti-corrosion paint colour. Above the sheer line, which is the upper edge of the uppermost strake of the hull plating, the bulwarks are painted white, as are also the after deckhouse and the midship superstructure and bridge. The inside of the ventilator cowls are painted red.

The funnel and masts are yellow ochre or buff, and the Pleno heating and ventilating unit with the cowls from the exhaust fans are painted the same colour. The lifeboats are white with brown or varnished sheer strakes. Originally the funnel cap was painted the same colour as the funnel itself but in recent photographs it is black.

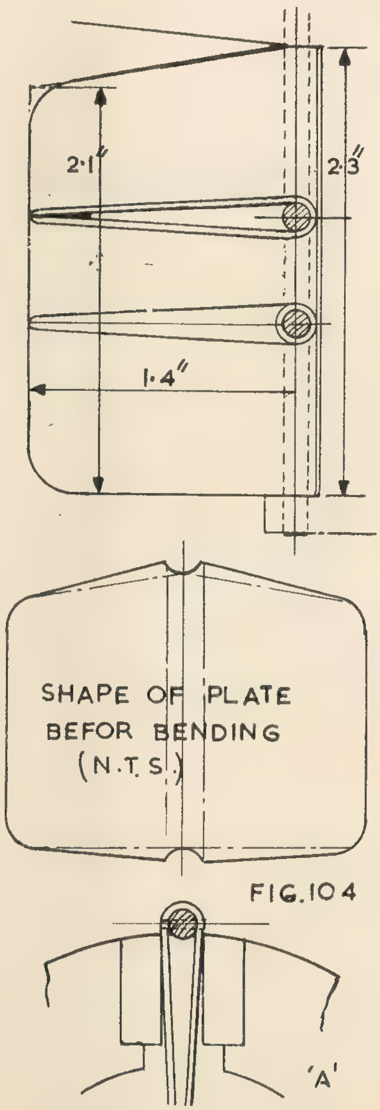
The cranes were originally white and the jibs buff, but I believe the entire crane is painted buff at present. In any case there is often a change in the small details. The dark edge of the moulding around the top of the wheelhouse should not be overlooked, nor the dark colour of the teak rail around the railings and the upper edge of the bulwarks.

Queries about any point not made clear will be welcomed by me; they should be addressed care of the editor, 19-20, Noel Street, London, W1.

In Part 18 (col. 3, page 350) in a reference to the arms for after davits I wrote: The arms are fitted with track rollers and guide pulleys as already described for the two forward davits, and they are assembled in the tracks in exactly the same way. This should read: . . . for the two forward davits, *but on their inner sides only*, and they are assembled . . .

At the end of this column I spoke of: the forward track of each davit. Please delete " the forward " and substitute *each*.

In the October 3 instalment the captions on pages 473 and 474 were transposed.



Details of the rudder construction

Propelling power boats

FOR those who are completing " St Ninian " the question will eventually arise of fitting a power unit. In the October 31 issue Edgar T. Westbury will begin a series dealing with the problems of propelling power boats. He will describe several kinds of power installation—electric, steam and internal combustion—and their suitability for various classes of hull. Problems of transmission will also be dealt with.

LOCOMOTIVES I HAVE KNOWN

LAST month—in article 41—I dealt at length with G. J. Churchward's Saint class. This month I have equally as much to say about his Star class.

In 1903 the Great Western Railway bought a 4-cylinder compound 4-4-2 engine that became No 102 *La France*; she was an exact mechanical duplicate of the very celebrated engines of the same type then putting up some wonderful performances on the C.F. du Nord in France, and Churchward was much impressed by her design, construction and performance.

The provision of a divided drive between two axles especially appealed to him, and in 1905, when he decided to put in hand a design for a 4-cylinder express passenger engine, he adopted the divided drive, but he could not tolerate the idea of compounding a locomotive for service on the GWR, as a standard.

The proposed 4-cylinder engine was put in hand at the Swindon factory, and was completed in April 1906. This was No 40, and she created wide interest both inside and outside the locomotive profession, for she was virtually a new type of steam locomotive; nothing quite like her had been seen before.

The novelty lay in the provision of four simple-expansion cylinders with the drive divided between two axles and the operation of the four valves by only two sets of valve gear, necessitating a 180-deg. setting for each pair of cranks on each side of the engine.

One pair, of course, was set at 90 deg. to the opposite pair, and in this way an almost perfect balance of reciprocating and rotating masses was automatically achieved.

The valve gear itself was a novelty for English locomotives, though No 40 was the only GWR locomotive ever to have it. It was directly derived from the Stèvart gear, which R. M. Deeley had adopted on his 999-class 4-4-0 2-cylinder engines on the Midland Railway.

Its chief feature was that the lap-and-lead function of each valve was derived from the reciprocation of the main crosshead on the opposite side of the engine. But, whereas in the original gear as designed by Stèvart for use on small 2-cylinder marine and stationary engines, and by Deeley on his locomotives, the two valve rods were of unequal lengths. Churchward modified the arrangement so that not only were there less parts, but the two valve rods were of equal length and the two sets of gear alike mirror-wise.

At Swindon this gear was unofficially called the "Scissors" gear because of its vague similarity to a pair of scissors. It worked very well and remained in No 40 until 1929, when she was rebuilt as a Castle.

This fine engine, on trial, was so successful that an order was passed to the Swindon factory for ten more, to be generally similar to No 40 but with the 4-6-0 wheel arrangement and —to avoid the complication of the scissors valve gear—a specially-designed arrangement of the Walschaerts gear, the two sets of which were to be operated by two large eccentrics mounted on the leading coupled axle between the two cranks.

From that day in 1907 all the 4-cylinder express locomotives built for the GWR had this arrangement of valve gear; it was never altered.

The valves of the two outside cylinders were operated by means of two horizontal cranked levers which were more ingenius than might appear at first sight. Each lever was pivoted at about, *not* exactly, the middle, the vertical pivot being carried by a bracket attached to the main frame. The inner arm of the lever was knuckle-jointed to the inside valve rod which projected rearwards from the inside valve chest; the outer arm was similarly jointed to the outside valve rod which projected forwards from the outside valve chest.

So far, the arrangement is similar to that in any other 4-cylinder engines employing two sets of valve gear for operating four valves. But Churchward realised that, due to the effect of the angularity of the connecting-rods, a straight lever causes dissimilar timings of the port openings in the two adjacent valve chests. Thus, to avoid this undesirable state of affairs, he cranked his lever so that the rearward angle between the two arms was 167 deg., ensuring that the

No 44 by J. N. Maskelyne — G. J. Churchward's

timings of the port openings were similar and simultaneous in each direction of valve movement. Clever, wasn't it ?

In this way the masterpiece Churchward Star class came into being. The first engine was No 4001, *Dog Star*, a never-to-be-forgotten favourite of mine. She was followed by No 4002 to 4010, named respectively, *Evening Star*, *Lode Star*, *Morning Star*, *Polar Star*, *Red Star*, *Rising Star*, *Royal Star*, *Shooting Star* and *Western Star*.

To this set of choice names must be added *North Star*, which No 40 was christened in September 1906; she was re-numbered 4000 in 1912. She had proved her worth. Her ten immediate successors very soon did the same with 3 tons pull at 70 m.p.h. —and, into the bargain, fully demonstrated the superiority of six-coupled wheels. *North Star* was converted into a 4-6-0 in 1909.

These splendid engines created quite a sensation fifty years ago; their performances placed them far ahead of any other comparable locomotives of the period, and for the next twenty years locomotive engineers seemed to be wondering how it was done.

Moreover, the consumption of coal and water in the Stars was little more, if any, than that of the French compounds, two more of which—larger than *La France*—had been purchased by the GWR in 1905, but were soon ousted from the West of England main line by the Stars.

In 1908 ten more Star-class engines, Nos 4011 to 4020, were built and named after Knights. In these the former swing-link bogie was replaced by one having side-control springs and outside bearers as in the French engines, while No 4011 was equipped with a superheater, after some experiments in this direction had been made with No 4010.

In 1909, Nos 4021 to 4030 appeared and were named after Kings of England; they were followed by Nos 4031 to 4040, the Queens, in 1910-11; Nos 4041 to 4045, the Princes, in 1913; Nos 4046 to 4060, the Princesses, in 1914, and Nos 4061 to 4072, the Abbeys, in 1922-3. All are now withdrawn.

No 4041 was fitted with 15-in. instead of 14½-in. cylinders, which caused some eyebrows to be lifted by locomotive men who seriously doubted Churchward's sanity in expecting the boiler to steam four 15-in. cylinders. No 4041 was so successful, however, that Nos 4046 to 4072 were built with 15-in. cylinders and the entire class was eventually fitted with them. Also, from 1913 onwards, superheaters became standard equipment.

Between 1925 and 1940, sixteen of these engines were reconstructed as Castles, but the rest remained virtually unaltered except for minor details. And it is interesting to note that, though they changed their sheds during their last years, they were always employed on the best main-line express passenger work in their districts.

They were very free-running engines and, for their size, extremely powerful. The following dimensions became standard for the whole class: Cylinders 15 in. dia., 26 in. stroke, with piston valves 8 in. dia. Wheel diameters, bogie 3 ft 2 in., coupled 6 ft 8½ in. The wheelbase was 27 ft 3 in. divided into 7 ft plus 5 ft 6 in. plus 7 ft plus 7 ft 9 in.

The Walschaerts valve gear gave a valve travel of 7¼ in.; the valve lap was 1⅝ in. and the lead was ⅛ in. On the exhaust side there was no lap or clearance, the valves being line-on-line with the ports. Steam ports were 1¾ in. wide, the exhaust 4 in.

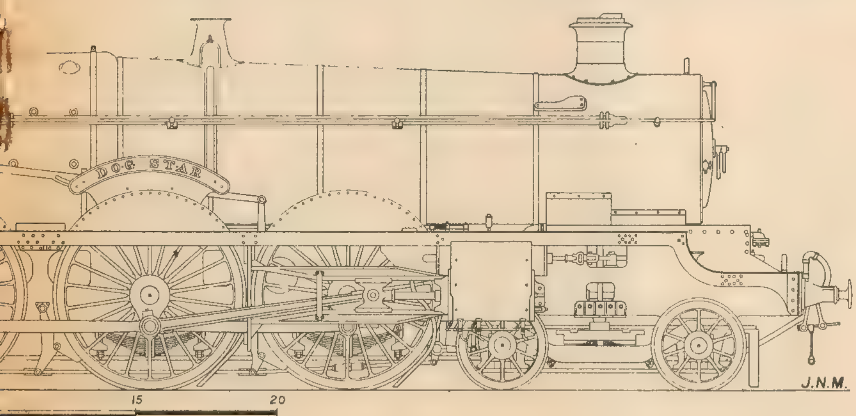
A standard No 1 boiler was included, pitched 8 ft 6 in. above the rails. All its other particulars were as given in article No 41. The front overhang of the engine was 3 ft 6 in., the back 6 ft 6 in.

The tenders varied: 3,000-, 3,500- and 4,000-gallon types were all in use on these engines. My drawing shows a Collett rebuild of a Churchward 3,500-gallon tender as attached to *Dog Star* during her last years. The re-building consisted mainly of the ugly modifications to the spring hangers. It is also worth noting that this tender was fully lined whereas the engine had no lining.

Incidentally, the Stars were originally fitted with equalisers between the springs of the six coupled wheels. In later years, springs were made more flexible and the equalisers were abandoned.

No 4003 *Lode Star* is preserved at Swindon as a memento of an epoch-making class. ▣

STAR Class, GWR



A simple locomotive for gauge 1

A LOCOMOTIVE—based on a design I prepared as part of a scheme on which the late Mr Stuart Turner was working as far back as 1924—is now being built in the ME workshop.

Mr Turner had intended to produce castings and materials for some simple steam engines of various kinds, including a locomotive, but, unfortunately, he died before production could be put in hand.

The drawings for the locomotive, which were to have been my contribution to Mr Turner's scheme, have remained in my possession ever since.

I must emphasise, however, that the whole basis of the Stuart Turner engines was to have been simplicity of machining and construction, so that any novice could have built any one of the models with very little equipment,

The locomotive is of freelance design, in that it is not a scale replica of any particular prototype, but its appearance could easily be adapted to suit any outside-cylinder 4-4-0 that the builder might fancy. It is spirit-fired, has a boiler of the Smithies water tube type and is intended to give long runs with heavy trains on a gauge 1 scenic railway.

In the construction of this first example, commercial castings, obtained from Bonds o' Euston Road, have been used for cylinders, wheels and eccentrics. All other details have been specially made to the original drawings, with slight modifications.

After all, I have learnt a lot during the thirty-four years since the drawings were made !—J.N.M. ▣

ZOE

LBSC provides instructions for testing the boiler and goes on to describe the smokebox and its accessories

Continued from 3 October 1957, pages 484 to 486

I MENTIONED in the last instalment of the narrow-gauge passenger hauler that the tender pump could be used to supply the necessary pressure for testing the boiler hydraulically, and here are the details for making that component.

The drawings show it made with a piece of tube for a barrel mounted on a stand bent up from a strip of brass, but a pump casting comprising barrel, stand and anchor lug for the links can be used if the builder prefers it.

To machine the casting, chuck one end of the barrel in the three-jaw—see that the outer end runs truly—and tighten the jaws well. Face, centre, drill through with 23/64 in. drill, ream $\frac{3}{8}$ in. and face off the other end; drill four No 30 holes in the base and a No 41 hole in the top of the anchor lug. The valve box, ram, lever and links are made and fitted exactly as described for the built-up version illustrated.

The barrel of this is a piece of brass treblet tube, the inside diameter being $\frac{3}{8}$ in. Face the ends in the lathe to an overall length of $1\frac{3}{4}$ in. Treblet tube should be smooth enough inside to be used without any treatment but if not available ordinary tube can be used.

After facing to length, wind a bit of emerycloth around a skewer or pencil until it fits the tube loosely; grip this in the chuck and run the tube up and down it with the lathe running as fast as possible. A minute or so of this treatment will make the inside of the tube as smooth as glass.

The stand is bent up from a strip of 3/32 in. sheet brass, 1 in. wide and 4 in. long, to the dimensions shown in the section. This can be done in the bench vice, a short piece of iron bar about $1\frac{1}{4}$ in. × $\frac{1}{8}$ in. being used as a packing block. On the centre line of each end at $\frac{5}{8}$ in. from the bottom drill a No 30 hole.

Check to see if the holes are level by putting a piece of $\frac{1}{8}$ in. rod through them; if all right open out the holes until the barrel fits them very tightly. Push it through until it overhangs an equal amount at each end, and solder it. Drill two No 30 holes in each foot for the holding-down screws and another in the middle of the top for the stem of the anchor lug.

Part off a 1 in. length of $\frac{3}{8}$ in. round rod. Chuck in the three-jaw, centre, drill through with No 34 drill, open out and bottom with 7/32 in. drill and D-bit to $\frac{3}{8}$ in. depth, slightly countersink the end and tap $\frac{1}{4}$ in. × 40. Reverse in the chuck and repeat the operation, but instead of using the D-bit nick the hole with a small chisel made from a bit of 3/32 in. silver-steel and put a $\frac{1}{8}$ in. reamer through it.

Drill a 5/32 in. hole in the middle of the side, piercing the reamed hole, and tap it $\frac{3}{16}$ in. × 40. Diametrically opposite at $\frac{3}{16}$ in. from the D-bitted end drill another 5/32 in. hole and silver solder a $\frac{1}{4}$ in. × 40 union nipple into it.

Chuck a piece of rod any size larger than $\frac{3}{8}$ in. and turn a full $\frac{3}{8}$ in. of it to a press fit in the pump barrel. Face the end and part off at $\frac{3}{8}$ in. Reverse in the chuck, turn down $\frac{1}{8}$ in. of the end to $\frac{3}{16}$ in. dia. and screw $\frac{3}{16}$ in. × 40. Centre and drill through with No 40 drill. Press this into the pump barrel and screw the valve box on to it, taking care that the D-bitted end with the union nipple is at the top.

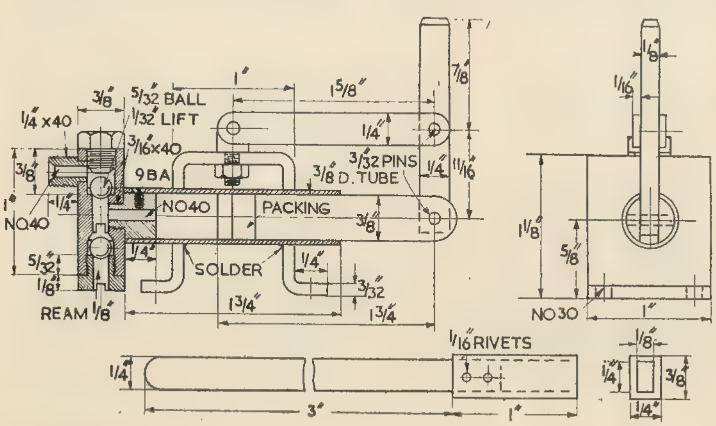
Seat a 5/32 in. rustless ball on the reamed seating and make a cap to suit from $\frac{3}{8}$ in. hexagon rod—just long enough to allow the ball 1/32 in. lift. Bevel it as shown, to allow free exit for the water.

A similar cap is made for the bottom end, but as this one forms the seating for the suction valve ball drill it No 34, ream $\frac{1}{8}$ in. and cross-nick the head. Before screwing the caps in permanently fit a 9 BA setscrew in the barrel plug as shown, and soft solder the joint between the barrel and valve box, which will seal both the plug and the screwed spigot. Don't attempt to silver solder it because the heat will soften the barrel; it will distort whether it is a casting or tube.

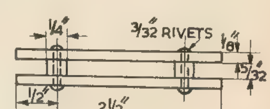
The ram is a 2 in. length of $\frac{3}{8}$ in. round bronze or rustless steel, which should be a nice sliding fit in the barrel without any need for turning. If not available, turn it from the next size larger.

Face the end, and at $\frac{1}{8}$ in. from it turn a $\frac{3}{16}$ in. packing groove $\frac{1}{8}$ in. deep. The other end is rounded off in the chuck, then slotted $\frac{1}{8}$ in. wide and $\frac{1}{2}$ in. deep by the method used for slotting valve forks previously described.

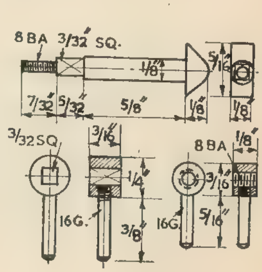
Beginners should drill the hole for



Left: The tender hand pump. *Right*: Smokebox crossbar



Right: Dart and handles



the pin before slotting, using a No 43 drill, as this ensures that both ends are exactly in line—but be sure and cut the slot at right angles to the drilling !

The lever is a piece of 1/8 in. × 1/4 in. brass or nickel-bronze 1 3/4 in. long. Round off one end, and at 1/8 in. from it drill a No 41 hole. Drill another at 11/16 in. away, and slightly bevel the upper end. The two links are 1 7/8 in. lengths of 1/4 in. × 1/16 in. brass or nickel-bronze, rounded at the ends and drilled No 43 at 1 5/8 in. centres.

The anchor lug is a piece of the same kind of material as the lever. Chuck truly in the four-jaw, turn 1/4 in. length to 1/8 in. dia. and screw 1/8 in. or 5 BA. Part off at 5/16 in. from the shoulder, round the end and drill a No 41 hole through it. Put the stem through the hole in the top of the stand and secure with a brass nut.

Pack the groove in the ram with a few strands unravelled from a bit of full-size hydraulic packing (usually tallowed yarn) then insert in the barrel and assemble the lever and links as shown, using bits of 3/32 in. drawn bronze rod for pins. They should be a squeeze fit in the links and ram and a working fit in the lever but if they should be slack don't worry, just rivet the ends over very slightly.

When in the tender the pump is operated by an extension handle through the filler hole. The handle is a piece of the same material as used for the lever—about 3 1/2 in. long, with a socket 1 in. long at the end as shown.

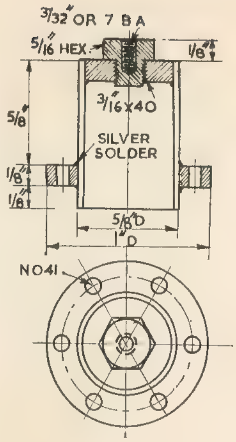
The socket may be made of rectangular brass tube, which is a commercial article, or it may be made from 16-gauge sheet brass bent round the handle and the joint silver soldered. It should slip easily over the pump lever.

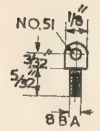
THE DOME

It will be necessary to fit the dome before testing. It can be made from a piece of 5/8 in. copper tube of 16- or 18-gauge the ends being faced off in the lathe to 7/8 in. length. One end is plugged.

Chuck a piece of 5/8 in. rod, face the end, centre, drill 7/32 in. for 1/4 in. depth, tap 1/4 in. × 40, turn 1/4 in. of the end to a tight fit in the tube, and part off a 1/8 in. slice. Drive this into the tube.

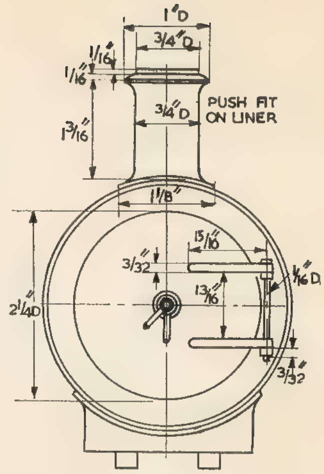
For the flange chuck a piece of 1 in. round rod, face off, centre and drill 1/2 in. for about 1/4 in. depth. Open out with a drill or boring tool until the hole is a tight fit on the tube. Part off a 1/8 in. slice and drill six No 41 holes around it as shown in the plan. Press it on to the open end of the tube until 1/8 in. projects, then silver solder both the flange and plug at one heat.





Above: Hinge lug

Left: The dome



Right: The front of the smokebox

Chuck by the plugged end and take a skim off the flange to ensure a true seating with the dome bush. Insert it in the bush on the boiler and secure it by 3/32 in. or 7 BA brass screws, locating and tapping the holes as described for the cylinder covers.

Put a 1/64 in. Hallite or similar gasket between the flange and bush, and fit a cap to the tapped hole like the one on the valve box of the pump.

HOW TO TEST THE BOILER

The easiest way to seal the steam-pipe hole in the smokebox tubeplate and the 5/8 in. hole in the backhead (as the latter isn't tapped and cannot be screw-plugged) is to take a piece of 1/8 in. rod a little longer than the boiler and put a few threads on each end.

Put this through the two holes, then on each end put a rubber washer about 1 in. dia.—these can be cut from a scrap motor-tyre tube—then a metal washer of similar size about 1/8 in. thick. I use two stamped brass blanks with a No 30 hole in the middle of each. Put a nut on each end and screw up until the washers are tight against the plates.

Make two adapters for the safety-valve bushes. These are pieces of 5/8 in. rod with one end turned down and screwed to fit the bushes; the other end is turned, screwed and drilled exactly the same as a 1/4 in. × 40 union nipple. Screw them in tightly with a gasket between each flange and bush, after filling the boiler with water. Beg, borrow or otherwise acquire a full-size pressure gauge reading to not less than 200 p.s.i. (mine reads to 360) and connect this to one of the adapters by a 1/8 in. pipe and suitable unions.

Next stand the tender pump in a pan of water and connect the union nipple on the valve box to the other adapter by a similar pipe and union nuts.

A few strokes of the pump operated with the extension handle will send the gauge finger up to 50 lb. Stop and take a look to see if there is any leakage. If there is, see to it right away. Then pump up to 100 lb., and investigate again, repeating at 130 lb. and finally at 160 lb. If there is a slight movement of the firebox crown sheet, about 1/32 in. or so, don't let it worry you—it will only be the soft copper settling itself in the best position to resist the working pressure.

If all is tight and no distortion is apparent at 160 lb. the boiler is ready for service. To make assurance doubly sure let it stand a little while before letting the pressure off.

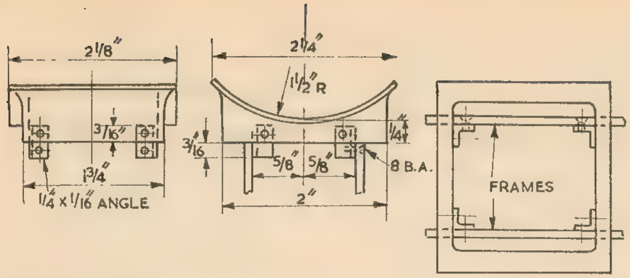
May I reassure beginners that there is no danger whatever in testing such a boiler? As the slightest fault in a joint or plate instantly releases the pressure an explosion is impossible.

THE SMOKEBOX

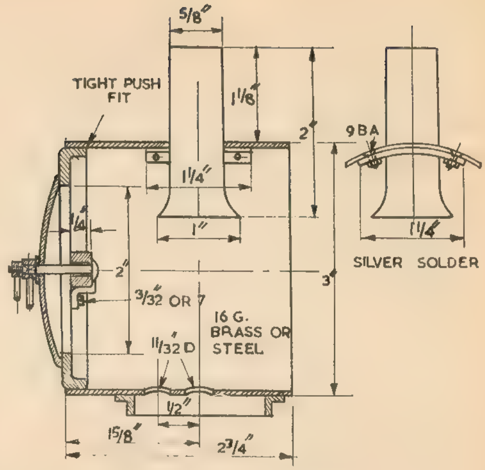
The smokebox is circular and rests on a saddle which may either be cast or built up. The barrel is a piece of 16-gauge brass or steel tube 3 in. dia. with the ends squared off in the lathe to a length of 2 3/4 in. It may be held in the three-jaw if a disc of wood or metal or a wheel casting of suitable size is put in the end to prevent the barrel being distorted by the pressure of the chuck jaws.

Drill a 39/64 in. hole in it at 1 1/8 in. from one end and ream it 5/8 in. Exactly opposite drill an 11/32 in. hole for the blastpipe, with another 1/2 in. ahead for the steam pipe.

The chimney liner is a 2 in. length of thin tube 5/8 in. dia., with the bottom end belled out to 1 in. dia. This can be done by softening the tube and



Above: *The smokebox saddle*



Right: *Section of the smokebox*

driving in a piece of metal turned to the shape shown. Alternatively, it may be spun out by holding in the chuck and applying a burnishing tool to it.

Cut a piece of 16-gauge copper $1\frac{1}{4}$ in. square, drill and ream a $\frac{5}{8}$ in. hole in it, bend to the radius of the inside of the barrel, push the liner through from the concave side, leaving $1\frac{3}{16}$ in. projecting, and silver solder the joint. If any silver solder should seep through to the convex side file it off.

Push the liner through the hole in the barrel from the inside and secure the flange to the barrel by four 9 BA countersunk screws put through No 48 holes drilled and countersunk at the corners of the flange and nutted inside the barrel.

The front ring may be cast or knocked up from a $3\frac{1}{2}$ in. × $\frac{1}{8}$ in. stamped brass blank, using the smokebox tubeplate former. Turn and fit it in exactly the same way as described for the tubeplate; it should be a tight fit in the barrel. Then chuck it with the convex side outwards, cut a 2 in. hole in it with a parting tool set crosswise in the rest and face it all over. A casting will have the hole already in it.

Chuck with the flange held from the inside—on the outside of the top steps of the outside jaws—turn to fit the barrel and face all over.

A cast door will have the hinge straps cast on, with a chucking piece on the convex side. Grip this in the three-jaw and face off the edge of the door to fit airtight against the front ring.

You can't turn the outside of the door without cutting off the hinge straps, so centre and drill a No 30 hole through the door, and part off the chucking piece. The outside of the door will then have to be smoothed off with a file.

A door can be made from a $2\frac{1}{4}$ in. stamped brass blank, $\frac{1}{8}$ in. thick. Soften it by heating to red and plunging into water, then lay it on a block of lead and hit it with the ball end of a hammer head, starting from the middle and working outwards. This will dish it.

Chuck with the concave side out, centre and drill No 30 and face off at the middle to 1 in. dia. Chuck a stub of $\frac{3}{4}$ in. brass rod and turn a pip on the end $\frac{1}{8}$ in. dia. and $\frac{1}{8}$ in. long, facing the shoulder truly. Put the pip in the hole in the door with the faced shoulder butting against the faced circle and solder it. Chuck the stub in the three-jaw—and the door can be turned all over on the outside, trued up on the edge, and the edge on the concave side faced. Melt out the stub and fit two hinge straps made from strips of 18-gauge brass 3/32 in. wide.

Bend the ends into a loop with a small pair of roundnose pliers and silver solder them. If the hole fills up, just put a No 51 drill through. Rivet them to the door with bits of domestic pins.

The lugs are made from 3/32 in. × $\frac{1}{8}$ in. brass strip. You can cut this from 3/32 in. sheet quite easily. Chuck truly in the four-jaw to turn and screw the stem, then part off at $\frac{3}{16}$ in. from the shoulder, and file and drill the head as shown.

The crossbar is made from two $2\frac{1}{2}$ in. lengths of $\frac{1}{8}$ in. × $\frac{1}{4}$ in. steel strip, with 5/32 in. × $\frac{1}{4}$ in. spacers between, like those used between firebars—just slices parted off a $\frac{1}{4}$ in. rod drilled No 41. Drill the bars with the same drill at $\frac{1}{2}$ in. from each end while clamped together, then assemble as shown, with two 3/32 in. iron rivets.

The crossbar is supported across the middle of the hole in the ring by two brackets bent up from $\frac{1}{16}$ in. × $\frac{1}{4}$ in. steel strip attached to the inside of the ring by a 3/32 in. or 7 BA screw in each (see section of the smokebox).

The dart is made from $\frac{5}{16}$ in. round steel. Chuck a piece and turn the first 7/32 in. to a shade under 3/32 in. dia. and screw 8 BA. File the next 5/32 in. to a 3/32 in. square by the simple method I have described several times, and turn the next $\frac{5}{8}$ in. to $\frac{1}{8}$ in. dia. and part off at $\frac{1}{8}$ in. from the shoulder. File the head flat and to the shape shown.

For the key chuck a bit of $\frac{1}{4}$ in. steel rod, centre and drill 3/32 in. for $\frac{1}{4}$ in. depth, part off a $\frac{3}{16}$ in. slice, and either drive a square drift through the hole or file it square with a watchmaker's square file to fit the square on the dart.

Drill a No 55 hole in the side, tap 10 BA and screw in a handle made from $\frac{1}{16}$ in. steel. For the locking handle chuck a piece of $\frac{3}{16}$ in. steel rod, centre and drill No 51, part off at $\frac{1}{8}$ in. full, fit a handle as before, then tap 8 BA.

Assemble as shown in the section of the complete smokebox, putting a $\frac{1}{8}$ in. steel washer between the key and the door. Set the door centrally on the ring, then carefully mark the position of the hinge lugs under the eyes in the hinge straps.

Centre pop, remove the door, drill the pops No 51, tap 8 BA and screw in the lugs. Replace the door and put a $\frac{1}{16}$ in. pin through the lot. Thread one end and screw a tiny tapped boss on it to prevent its falling through. A big domestic blanket pin, already headed, can be used if available; it only needs cutting to the right length.

The smokebox saddle illustrated is a casting, and all that it needs is a clean up with a file, and four $\frac{3}{8}$ in. lengths of $\frac{1}{4}$ in. × $\frac{1}{16}$ in. brass angle riveted to it with $\frac{1}{16}$ in. rivets in the position shown.

The chimney casting is bored to a push fit on the liner and turned to the shape shown—or any other shape the builder might fancy. Don't erect the smokebox yet nor fit the front permanently until all the blobs and gadgets have been fitted to the boiler.

● *To be continued*

MAINTENANCE—
in miniature

ERIC HAWKESWORTH, builder of a 1½ in. scale Royal Scot, is well qualified to advise on this important aspect of the hobby

ROUTINE maintenance of small locomotives can be a happy and absorbing task. As in full size, the steam engine stands or falls by the regular attention it gets, and it is a rather dreadful reflection on twentieth century man that this amiable giant is being pushed to the wall without so much as a fight, mainly—so they tell us—because of "poor availability" and "too much maintenance."

Had British Railways servicing methods advanced with the times instead of following a system that was barely adequate thirty years ago—many professional locomotive men support me on this point—steam might still have its tail up. It is still not too late for the powers that be to equip an experimental running shed with a stable of oil-fired machines serviced by really up-to-date plant and show that steam can still pay. Specifically, the lines to think along are paraffin jet-cleaning bays and pressure-steam raising from external boilers.

Maintenance starts on the drawing board no matter what the scale and, unless a designer builds "stripability" into his creation, there will be trouble aplenty for the service men in future years. It's far easier to look after a vintage car than some present-day types!

I gave considerable thought to the maintenance aspect when building my 1½ in. scale *Royal Scot* locomotive. It was decided to make cab, running boards and wrappers independent units capable of easy removal from the engine without disturbing any steam connections. Fig. 1 shows how this scheme was accomplished.

Running boards were assembled first, complete with all detail such as smoke blinkers, wheel covers, steps, handrails and lamp brackets. Slots were cut on the inside edge to enable the units to slide into place without disconnecting anything, and small angle-iron brackets and six 2 BA bolts hold both boards in position.

Open fronted, the cab drops over all backhead pipes and fittings without disturbing a thing, and the whistle, steam brake and sanding-gear controls are mounted turretwise with trigger operating levers projecting backwards. The pole reverse lever—this is a scaled-up version of *Maid of Kent's* fore-and-aft stick—is attached to the left-hand side main frame member and fits through the cab floor via a suitable slot. Thus, there are no connections to the cab structure at all. A couple of long 2 BA screws pull the unit snugly into place on the rear dropped portion of the running boards.

The boiler barrel wrapper, which is disturbed only on a complete boiler removal, is secured by four wrapper bands, the centre pair of which carry handrail knobs riveted flush into the wrapper.

Eight 4 BA bolts are used to fasten the Belpaire firebox wrapper to the running boards. Correctly tapered, this wrapper carries dummy wrapper bands as shown and four handrail knobs—two each side—are permanently nutted into place. The safety valve base is tapped and screwed from the inside, and extra filling pieces, shaped to follow the barrel contour, are screwed on each side the firebox wrapper front to fit the lower half gap.

The joint between the barrel and the Belpaire wrapper is neatly masked with an L-section band made by sawing a piece of brass curtain rail down its middle. At the time of construction all metal sections were difficult to obtain and this stuff literally filled the gap. Fig. 1 shows how the T-portion of the cut-down rail made excellent beadings for the cab side openings.

WATER CONTROL TAPS AND VALVES

No rear holding-down brackets are fitted to the boiler; the foundation ring simply rests and slides, under expansion, on the back axle horns. It was considered that the cab would prevent upward movement—and enough holes had been drilled in the boiler anyway! For overhaul and

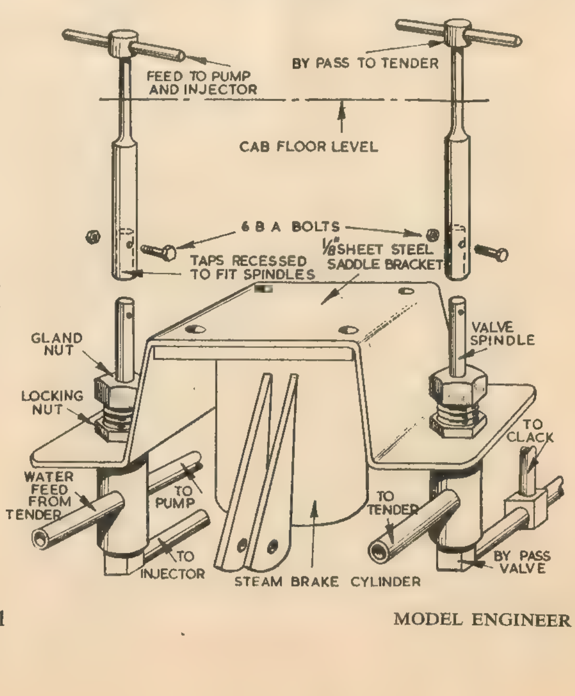


Fig. 2: Detachable water control taps

MAINTENANCE—in miniature

continued

testing the boiler can be removed from the frames well within the hour.

Unit construction was again used in the design and manufacture of the water-control valves. As seen in Fig. 2 both the water feed to the injector and pump and the pump delivery by-pass valve are located beneath the drag box under the cab. In this layout no pressure connections are required between the engine and tender.

Valves—they are to scaled-up LBSC design—are located each side, the steam-brake cylinder being screwed into holes in a sheet-steel saddle bracket. The bracket is bolted between the cylinder flange and the drag box, and this makes for easy removal.

The operating taps project through the cab floor and are locked to the valve spindles via a recessed hole and a 6 BA cross bolt. It is necessary to loose these bolts and withdraw the tap handles before removing the cab.

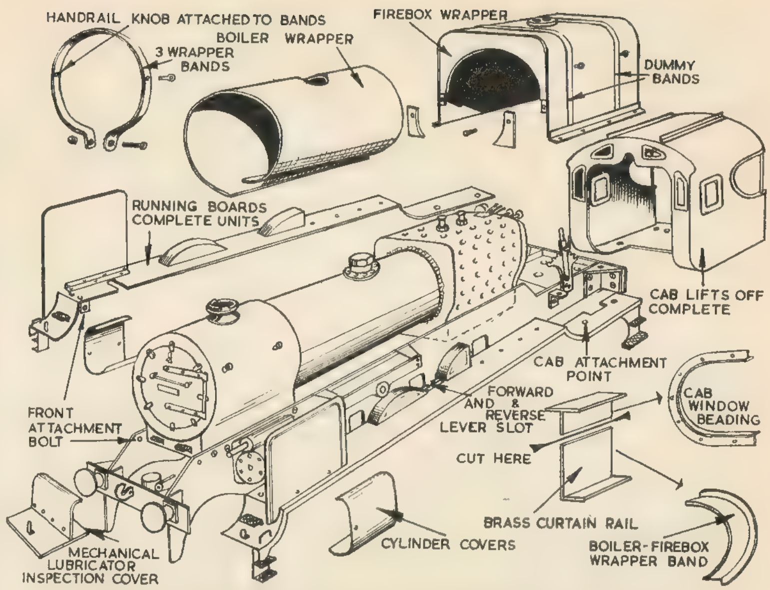


Fig. 1: Exploded diagram showing individual parts of ROYAL SCOT

MAINTENANCE-TESTING STAND

In practice water connection to the axle-driven pump is straight through the feed valve, i.e. it is never shut off, and turning the valve tap permits water to flow to the injector.

No inconvenience has been experienced in not having shut-off cocks on the tender pipes as the engine and tender are seldom parted during a season's operation.

Although a couple of strong boxes sufficed to support the engine in its early construction days the need for something more comprehensive in the way of a maintenance-testing stand was soon realised.

The design illustrated (Fig. 3) has proved to be worth its weight in gold. Built of angle iron and mild steel strip to the sections stated, the stand has six self-aligning ball races for the driving wheels to stand on. The front bogie wheels fit into shaped bolt on plates that are screwed to the main angle irons, and the engine is prevented from swinging off the rollers at the back end by a pair of restraining chains that clip over the cab buffer beam.

Ball races are nutted on to shouldered $\frac{5}{8}$ in. shafts, which, in turn, are located in tight-fitting slots at the driving wheel centres along the main top angle. Unless your engine's wheels are flat on the treads—not coned—self-aligning races must be used, otherwise you'll soon run a point-of-contact groove in the rotating wheels.

The addition of 4 in. dia. rubber tyred wheels, bought commercially and fitted to $\frac{1}{2}$ in. dia. axles nutted through the base angles, enable the complete stand and engine to be portable. The stand was of great help during valve-setting sessions, for it allowed valve events to be accurately determined with the engine in true running position, i.e. with all its weight on its wheels.

In the depths of winter it is sweet music, indeed, to fire up the Scot and listen to the soft bark of the exhaust while the big drivers rotate at about 60 r.p.m.

Model engineers who frantically build small locomotives one after the other in pursuit of perfection without ever really understanding what each engine will do are, to my mind, missing all the fun. Remember: Build, drive, fire, maintain—that's the way to run a train! ■

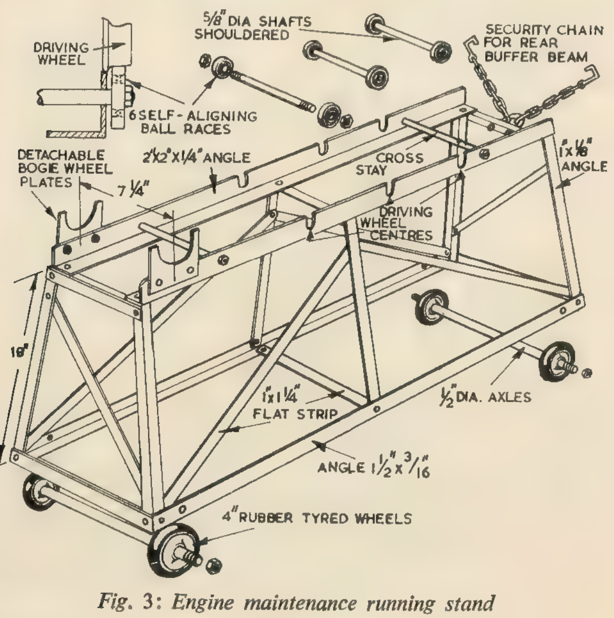


Fig. 3: Engine maintenance running stand

Do not forget the query coupon on the last page of this issue

READERS' QUERIES

This free advice service is open to all readers. Queries must be on subjects within the scope of this journal. The replies published are extracts from fuller replies sent through the post: queries must not be sent with any other communications: valuations of models, or advice on selling, cannot be given: stamped addressed envelope and query coupon with each query. Mark envelope "Query," Model Engineer, 19-20 Noel Street, London, W1.

Dynamotor conversion

I have recently bought an ex-WD motor, but unfortunately it has no wiring diagram. I wish to adapt this motor to run on 240 v. a.c. Can you help me, please?—N.G.C., Lowestoft, Suffolk.

▲ *Complete records of ex-Service equipment are not on file and it is, therefore, not possible to answer your question in specific terms.*

Not all types of dynamotors or rotary convertors are capable of being successfully converted to work as a.c. motors. A great deal depends on the details of their design. In most cases, however, conversion is very simply effected by removing the low tension "input" brushes of the machine and connecting the field winding in series with the high tension "output" brushes. Converted machines of this type generally tend to run at very high speed on no load but at a comparatively low torque, and slow up considerably under load.

Locomotive boiler

I note that LBSC has described a simplified form of locomotive boiler for $1\frac{3}{4}$ in. gauge. Will you please tell me if a boiler of that type would be suitable on a $\frac{5}{8}$ in. scale 3 in. gauge 0-4-0 having $\frac{7}{8}$ in. dia. cylinders and carrying 80-100 p.s.i.?—A.D.S., Cleveland Heights, Ohio.

▲ *The simplified form of locomotive boiler described by LBSC is not suitable for use with any pressure above 50 lb. to the square inch. For pressures of 80 lb. to 100 lb. a proper locomotive-type boiler is advised.*

Trepanning 8 in. discs

I have several 8 in. discs to cut in heavy gauge zinc. I propose using a trepanning tool in the drilling machine; would there be any objection to this?—J.J.C., Mile End, London.

▲ *It would be necessary to use a very heavy and powerful drilling machine to do this really successfully with the ordinary single point trepanning tool. A very slow speed would be desirable as the tool has a tendency to dig in and snatch unless the feed is very carefully controlled.*

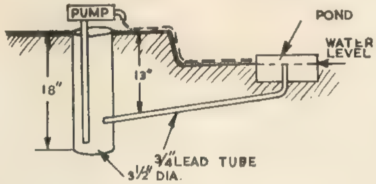
There is a type of trepanning tool made in the form of a disc with a flexible hacksaw blade bent round the outside, and this would probably be more satisfactory as it would avoid the tendency to snatch. Tools of this type are made by the Enox hacksaw manufacturers—namely, Frys (London) Ltd, 56 Southwark Street, London, SE1, and are obtainable from most tool shops.

A wooden backing pad is desirable for trepanning operations of any kind and clamps may be used to attach the sheet metal to the backing.

Waterfall pump

I wish to instal a pump to operate a small waterfall in my garden. I enclose a sketch and would welcome your opinion as to the practicability of the arrangement.—R.W.F., Maidstone, Kent.

▲ *The arrangement suggested in your sketch, with the pump located above ground and drawing water from a depth of 18 in., presents several difficulties, for it is not easy to lift*



R. W. F.'s suggested arrangement for a waterfall pump

water by suction to this height and, generally speaking, for installations of this nature it is desirable to locate the pump itself at as near water level as possible.

Certain types of pumps are arranged to be completely submerged so that they do not require to lift by suction at all. It is much easier to lift water on the delivery side of the pump, and suitable pumps—complete with motors—are supplied in all sizes by Stuart Turner Ltd, Henley-on-Thames, Oxon. The pumps are rated in output in gallons per hour, and if you have any idea of the amount required they would be able to supply you.

Driving a circular saw

I have a $\frac{1}{2}$ h.p. electric motor which I wish to use for driving a circular saw. Can you inform me what diameter saw is suitable for a motor of this size, and the number of r.p.m. a wood saw is usually run at? The motor runs at 2,800 revs.—M.V.B., Crowthorne, Berks.

▲ *To operate at the very highest output efficiency, circular saws are capable of absorbing a considerable amount of horse power, but a good deal of general work can be done quite efficiently at lower rates and, provided you are satisfied with moderate performance, a $\frac{1}{2}$ h.p. electric motor will drive a saw of 8 in. to 9 in. dia.*

A convenient working speed, though again not approaching maximum efficiency, would be 2,500 to 3,000 r.p.m.

Wind generators

Could you please give me some information on wind-driven generators commonly used—out here—for generating electricity for private use?

1 Would an old aircraft propeller make an efficient power unit?

2 Why are so few blades usually employed? It seems to me that a lot of air must escape when there are only two or three blades.—D.B.M., Tolmie Roadside, Victoria, Australia.

▲ 1 *An aircraft propeller could be used as a windmill, and most modern wind generators have a windscrew designed on similar aerodynamical lines. But if it is intended to couple the windscrew directly to the shaft of the generator without the use of gearing, it would need to be of much finer pitch than is normally employed for aircraft purposes in order to attain sufficiently high speed in wind of moderate velocity.*

2 *In a low-speed windmill such as employed for direct pumping purposes, multiple blades are an advantage, but for high speed windmills the factor of blade interference occurs and, generally speaking, a smaller number of blades would be better. There would even be advantages in using a single blade provided that it could be properly balanced, but the next best thing is a 2-bladed windscrew.*

A multi-purpose SAWBENCH

I. H. STEELS describes a home workshop machine that should prove invaluable for those jobs the wife keeps finding

HAVING recently moved into a new house and been confronted with a long list of jobs all marked urgent, I wondered where all the time was coming from to carry out the work of making built-in furniture and fitments of one sort or another.

I had erected my lathe fairly smartly and for the circular sawing I made up a mandrel carrying a 6 in. blade supported by an outer bearing carried in the tailstock. The table, 12 in. × 12 in., of $\frac{1}{8}$ in. plate was mounted on a pillar carried on the cross slide. This worked quite well for timber up to 1 in. thick and about 3 ft long.

Pieces of timber longer than that fouled the fixed window in front of which the lathe bench was situated. The procedure then was to take the glass out, feed through the strip, where my wife would catch it as it floated out over the end of the coal bunker! A rather Heath Robinson set-up, but one which enabled the job to be carried out more economically and quicker than by hand.

Last autumn, having a breathing space, I decided to make a proper job of the circular saw and to make it portable to allow for cutting up the long timber. I had by that time acquired the compressor shown and, for reasons of economy, I utilised the same driving motor. Also, having seen a small planer in use, I decided to make provision for such a machine to be added at a later date.

The overall sizes of the machine were dictated by the available space under the lathe bench, where it had to be parked when not in use. It measures 2 ft 5 in. high × 2 ft square, the saw table itself being 2 ft × 1 ft 6 in. wide.

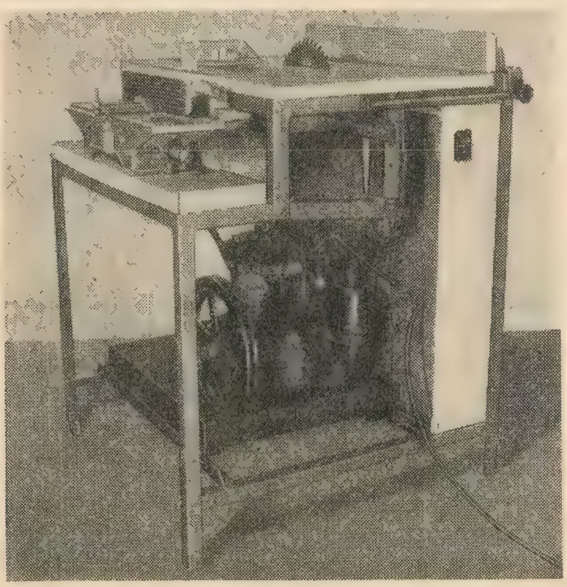
The framework is entirely constructed of 1 in. × 1 in. × $\frac{1}{8}$ in. angle iron. All the top joints are welded to give maximum rigidity without additional stiffening. The legs are stayed by "spells" of angle iron bolted on.

Two of these "spells" form the guide rails for support of the compressor base. This base of pressed steel rests on the flanges of the angle iron and is secured in position by setscrews passing through slotted holes in the rails. Thus, belt tension can be adjusted by sliding the compressor base along the rails.

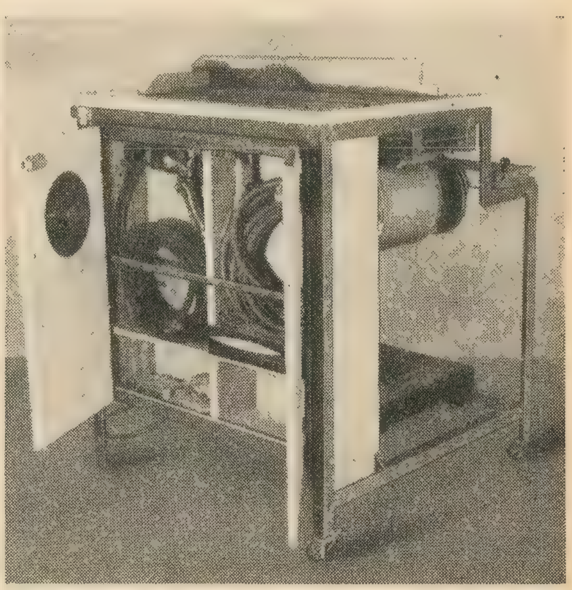
The $\frac{1}{2}$ h.p. electric motor and saw spindle housing are carried on 1 in. × 1 in. × $\frac{1}{8}$ in. angle iron frame 5 in. wide, which is hinged at its rear end. This frame, again of welded construction, is pivoted on two $\frac{5}{16}$ in. dia. bolts carried in brackets welded to the table top member. One side of the frame is extended forward to form a handle to raise and lower the spindle. The frame is spanned at its rear end by the motor platform of $\frac{1}{4}$ in. plate, to which the motor is bolted in the inverted position.

The spindle assembly was constructed from materials to hand without castings. The housing is a plain piece of drawn steel tube, $\frac{7}{8}$ in. i.d., $1\frac{1}{8}$ in. o.d., with shouldered bushes of meehanite pressed in forming plain bearings of $\frac{5}{8}$ in. dia. × $1\frac{1}{4}$ in. long. Lubrication holes were then drilled through the tube and bush and oilers fitted, but no distribution grooves were cut in the bore. Light oil, Vitrea 27, is used with entirely satisfactory results. Plain bearings are quieter than ball bearings too.

A view of the completed sawbench



The compartment housing the spray gun and brazing torch



The spindle was machined from some " tough " steel, origin unknown. The main diameter is $\frac{5}{8}$ in., being turned down to $\frac{1}{2}$ in. at each end. One end is screwcut and carries the blade clamped between heavy bevelled washers of $2\frac{3}{4}$ in. dia., the inner washer being pressed on. The other end of the spindle carries a grub-screwed collar for adjustment of end play and there is a keyway for location of the pulley. As it happened this was my first attempt at making a Woodruff cutter and, much to my surprise, I cut a nice clean keyway in spite of the shaft toughness.

Although the collar has not shifted in use, it is not a good design and I intend to slip on a screwed sleeve, sweat it in position, and use a screwed collar and lock-nut for adjustment. The pulley was machined from 2 in. dia. dural to take an A-size V-belt.

The spindle housing is supported on two light alloy saddle pieces $\frac{5}{8}$ in. wide and clamped to the angle iron frame by U-bolts. After lining up, holes were drilled and tapped from below through the frame and housing, and setscrews were used to dowel the housing in position.

This was to prevent any chance of movement due to belt pull or blade thrust. The saddle pieces were radiussed by fly cutting, an ordinary boring tool being held in the four-jaw chuck with the pieces clamped in the vice on the vertical slide.

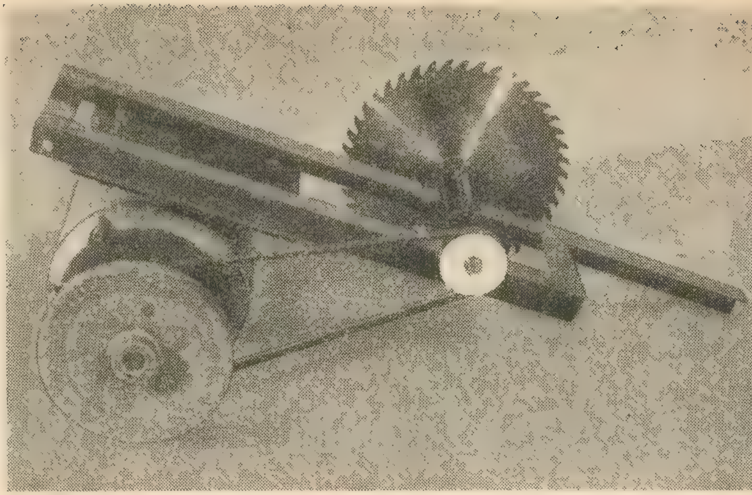
The table top

As mentioned already, the complete frame assembly is pivoted at the rear on two $\frac{5}{16}$ in. bolts, and downward movement at the front handle end is checked by the angle iron L-shaped bracket bolted on. The apparent slight droop is intended to allow an 8 in. dia. blade to lie below the level of the table at its lowest position.

A piece of $\frac{1}{4}$ in. plate riveted on to the bracket has a radial slot to allow clamping of the front end of the frame at any position of rise and fall. The weight of the motor is close to the pivots and very little effort is required to lift the spindle.

The table top is of $\frac{3}{4}$ in. Weyroc screwed to the structure by countersunk 2 BA screws. Holes are cut right through to clear spindle pulley oilers and blade cheek washers. There is a slot $\frac{1}{2}$ in. wide for the blade.

The top is completely surfaced by $\frac{3}{16}$ in. Hardec—a melamine plastic surfaced hardboard. This has the advantage of being very smooth and scratchproof, yet can easily be cut. The surface is actually in two parts, being separated by a gap of $\frac{3}{4}$ in., thus forming a groove for the mitre



Mechanism for driving the saw. The near-side pulley is used to drive the planer

fence guide. The surface is screwed to the chipboard top by countersunk wood screws, and a renewable loose piece is fitted around the blade slot as is usual.

A $\frac{1}{2}$ in. dia. mild-steel rod is used as the fence guide, mounted between two brackets made from 1 in. × 1 in. angle again. The fence is of $1\frac{1}{2}$ in. × $1\frac{1}{2}$ in. angle and is attached to the guide rod by means of a claw fixing which, by slackening the hand wheel right off, allows the fence to be removed. This leaves the table top quite clear and is necessary for cross cutting and mitre operations and for parking in its confined space under the lathe bench.

A 4 in. planer was obtained at a very reasonable price by advertising, and was mounted in position on a $1\frac{1}{4}$ in. thick timber board, the planer and saw pulleys being side by side. The same V-belt is used, tension being applied by lowering the saw spindle which moves the motor. The blade is thus out of sight when the planer is being used.

The motor pulley is a built-up three-step unit. The 4 in. dia. centre pulley is of cast iron and came with the compressor, which it drives by a B belt. A similar size single groove disc is bolted on one side which drives the saw, while a 6 in. dia. single-groove pulley bolted to its other side drives the planer.

A cupboard has been built-in to one side of the unit and its two compartments hold a brazing torch and spray gun with their respective accessories and tubing.

It is intended that sawdust chutes will be fitted, which, although very desirable, will have to be arranged so that they are quickly detachable to enable the saw blade to be changed.

In conclusion, I should like to add that the machine has proved extremely useful and well worth the four weeks or so it took to build. It takes only about 15 seconds to pull the machine out, raise the blade, and plug in, which is worth while even if only a couple of boards have to be cross cut.

The apparent distortion in the first two photographs was caused by the closeness of the camera. ■

Leyland centrifugal clutch

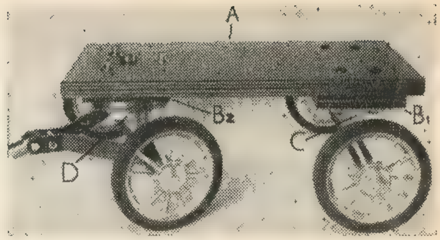
A centrifugal clutch, which automatically engages and disengages and dispenses with the need of a clutch pedal, has been designed and developed by Leyland Motors as an alternative drive to the fluid coupling which until now has been fitted to all Leyland vehicles equipped with the pneumo-cyclic semi-automatic or fully-automatic gearbox.

Although completely disengaged at speeds below 500 r.p.m., the centrifugal clutch automatically gives a positive drive at engine speeds above 750 r.p.m. when it transmits full engine torque. There is no permanent slip at normal operating speeds, representing lost engine revs and consequent loss in m.p.g., as there is with the fluid coupling. Nor is there any drag to absorb horse power when the bus is stationary in gear with the engine idling.

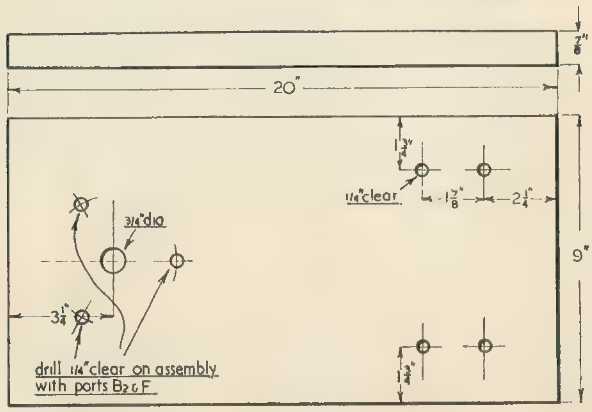
The new unit is similar to the standard Leyland single dry-plate clutch of $16\frac{1}{2}$ in. dia., but with the addition of six spring-controlled radially-disposed pivot weights, which, under the action of centrifugal force, start to engage the pressure plate at approximately 500 r.p.m. ■

A TROLLEY for the motor generator set

By DUPLEX



Above, Fig. 1: The trolley



Left, Fig. 2: The plywood platform

THE motor generator set used in my workshop is employed for a variety of purposes. Apart from its use as a source of electrical supply when charging batteries, it is also employed for driving certain electrical attachments fitted to the lathe. In addition, since the shop contains a number of small baths for the electrolytic treatment of materials, this process also makes use of the low-voltage d.c. power derived from this source.

It will readily be appreciated, therefore, that, rather than to continue festooning the workshop with wires, the provision of a mobile generator unit has received active consideration, resulting in the equipment about to be described.

The trolley (Fig. 1) consists of a heavy plywood platform mounted on cast brackets carrying the axles on which the rubber-tyred wheels are mounted. Then, as will be seen, a fore-carriage is provided, rigid in construction, enabling the trolley to be steered.

This method of steering follows agricultural practice and is designed to prevent any bending of the steering pin. A demountable handle is fitted—that shown being all that remains of a disused hydraulic jack. This particular handle divides into two parts and this enables it to be packed away in clips on the trolley when not needed.

CASTINGS

Fig. 1 depicts the socket for the handle attached to a wishbone fitting, forming part of the front axle of the trolley, and Fig. 2 gives details of the plywood platform *A* for the trolley, together with the two packing pieces *B*1 and *B*2. These are used to support the two aluminium castings *C* and *D* to which are secured the front and rear axles.

The platform and packing pieces are well coated with French polish before painting; in this way the plywood is protected against the ingress of damp that would otherwise destroy it.

Now to the two castings shown in Fig. 3. Some readers may prefer to make patterns in wood and send them to a professional foundry to obtain castings; others may consider carrying out this work themselves.

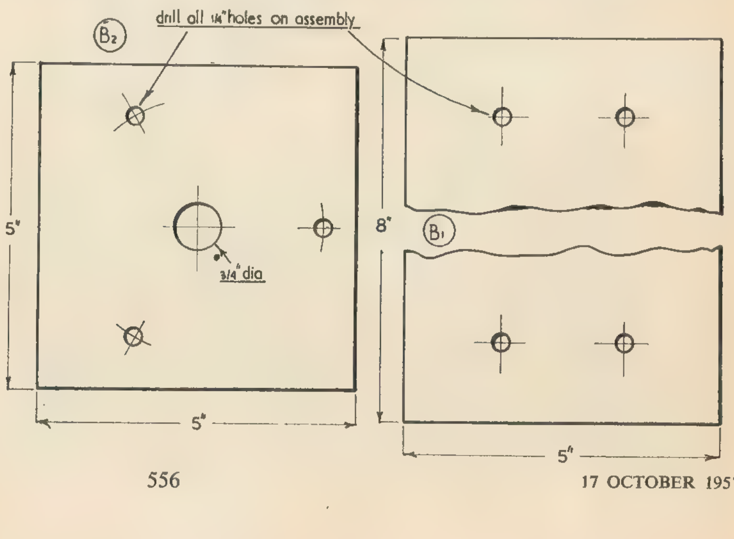
Both castings will need machining on the faces which abut against the plywood packing pieces and the axles respectively. The smaller of the two components can readily be machined in the 4-jaw chuck, but the larger casting may need to be set up for fly-cutting. This is a single-tooth milling process. The part, of course, may also be trued up by filing.

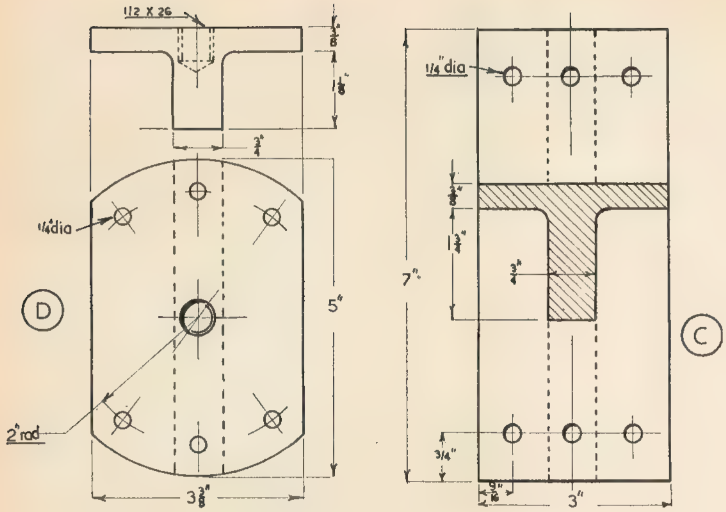
It is preferable to machine the part *D* in the lathe—if only to ensure that the $\frac{1}{2}$ in. dia. $\times$ 26 thread hole for the spindle *E* is tapped squarely. The spindle itself and its associate bearing *E*1 are illustrated in detail (Fig. 4) where a sectional view of the steering assembly is also given. The bush can quite well be made from mild steel as this material will wear perfectly satisfactorily in the circumstances.

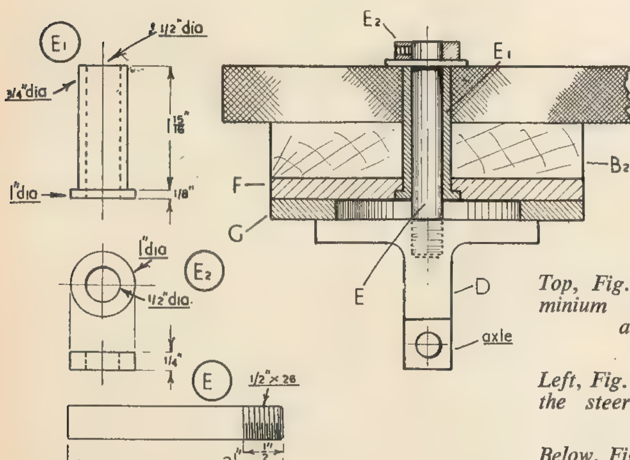
FRENCH POLISHING

A method of French polishing which can be used for treating the wooden parts of the trolley is employed in the shops of at least one

Below, Fig. 2 (contd): The distance pieces B1 *and* B2



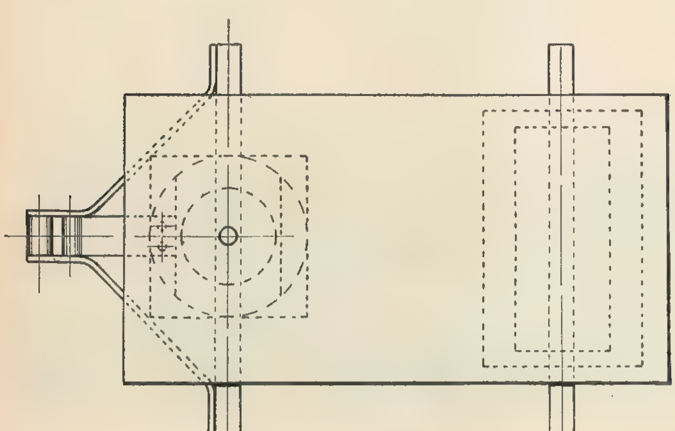




Top, Fig. 3: *The aluminium castings* C *and* D

Left, Fig. 4: *Section of the steering assembly*

Below, Fig. 5: *Plan of the trolley*



large aircraft manufacturer to finish certain models intended for use in the wind tunnel. I have used the technique when re-polishing the mahogany window frames of a vintage car, so can vouch for its efficiency and simplicity.

As the success of this manner of finishing woodwork depends very largely on the quality of the French polish used, it is advsiable to make this medium for oneself. French polish, as purchased from an oil and colour merchant is rather a thin liquid and is certainly unserviceable for the job in hand. To provide a good finish the polish should have the consistency of cream.

Making the mixture

To make a serviceable mixture, therefore, take 8 oz. of shellac crystals and dissolve them in ordinary methylated spirit. It is advisable to use a mechanical stirrer, for such an instrument removes the labour from paint mixing and ensures that the mixing of the pigment is perfect.

Put the methylated spirit, say $\frac{3}{4}$ pint, into a large Kilner jar or similar receptacle, start the mixer and add the crystals a little at a time, stirring until they have thoroughly dissolved in the spirit. When there is sufficient shellac in solution and the consistency of the polish is satisfactory, the mixture must be strained through an old silk stocking to remove any dirt and undissolved shellac.

To use the polish, first rub down the work with fine glasspaper, then apply the shellac with a brush. Four or five coats will be needed, and each coat needs to dry well before the next is applied. When the last coat has been added the work should be allowed to dry overnight and then rubbed down with grade 500 wet-or-dry abrasive paper in the *wet* condition.

Polishing

When the surface of the work is smooth, polish with Brasso or one of the car polishes, such as Karpol. The resulting finish is a somewhat softer polish than that obtained by ordinary French polishing and is, in my opinion, superior in every way. Moreover, it is very easy to carry out.

To return to the trolley, in Fig. 5 a plan view of the trolley is given. It will be seen that this drawing shows a centre tie for the steering wishbone. This part has, in practice, been found unnecessary; the wishbone is rigid enough without it.

In my next article I shall deal with the steering assembly.

● *To be continued*

POSTBAG

The Editor welcomes letters for these columns, but they must be brief. Photographs are invited which illustrate points of interest raised by the writer

STEAM TURBINES

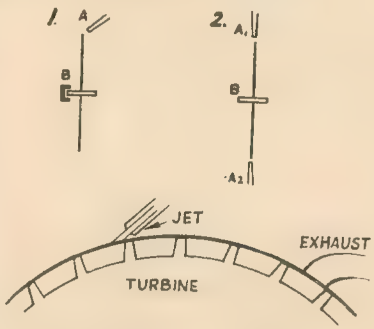
SIR,—The article by R. H. Mapplebeck on his model steam turbine, now capable of the remarkable speed of 137,000 revolutions per minute, is of great interest to me, and congratulations are due to him for his engineering ability.

While I found much of his article above my head, not having had a training in such fine engineering craft, from a logical point of view, where logic is an exposition of the principles of balance, I can make sensible suggestions for the improvement of his turbine, which he may care to examine in practice.

The first observation is that if steam is fed to one side of a turbine only, as he feeds it to the top perimeter, then there must be some thrust exerted *downward*, involving a loss of mechanical power on the bearings. But if two jets are fed in to the turbine, the second on the opposite side of the circle, then balance is attained, where upward thrust cancels downward thrust.

According to his article, there is a considerable end-bearing thrust, which can chew up a ball bearing in two minutes, and this can, I think, be obviated, together with its loss of mechanical efficiency.

If steam is fed to the turbine from the side as in (1) at point *A* then there is thrust exerted at point *B*. But if as in (2) steam is fed horizontally at points *A*1 and *A*2 on to a rather different type of turbine, then perfect balance and optimum mechanical efficiency is attained. Then there is neither downward thrust only, nor end thrust to loose mechanical efficiency.



G. H. Dalling's suggestion for balancing the thrust on a turbine

I would suggest that another type of turbine might be tried with good effect.

A closely fitting casing would no doubt add to efficiency if it managed to eliminate side losses from jet to exhaust. Perhaps there is some loss in the turbine as it is now where, presumably, the steam makes almost one revolution before finding exhaust space. But this point is not clear to me and I may have understood the path of the steam quite wrongly.

Birmingham. G. H. DALLING.

MATISA MACHINES

SIR,—With reference to S. Whitehall's letter [Postbag, August 8] we enclose a photograph of a heavier duty ballast cleaning machine than the one shown and which is now produced by ourselves in this country and of which ten are now in service with the various Regions of British Railways.

As with the machine that Mr Whitehall saw, the principle utilised for removing and screening track ballast is as follows:

A continuous toothed excavating chain passes under the sleepers and excavates the fouled ballast, whence it is passed by means of conveyors through a vibrating screen. The screen separates the reclaimed ballast from the fine spoil and returns it to the track. The spoil is then disposed of by means of the front conveyor into either wagons on an adjacent track or down the side of the embankment, etc.

Power is derived from a Leyland GU680 diesel generating set. All conveyors, the screen and the excavating chain are driven electrically. When travelling to the site the machine is completely self-mobile and can travel at speeds up to 30 m.p.h.

The complete equipment is divided into two vehicles, the smaller power wagon being utilised as a light locomotive for positioning the machine. When working the machine is recoupled so that the two driving cabs are adjacent and the front spoil conveyor protrudes ahead of the machine.

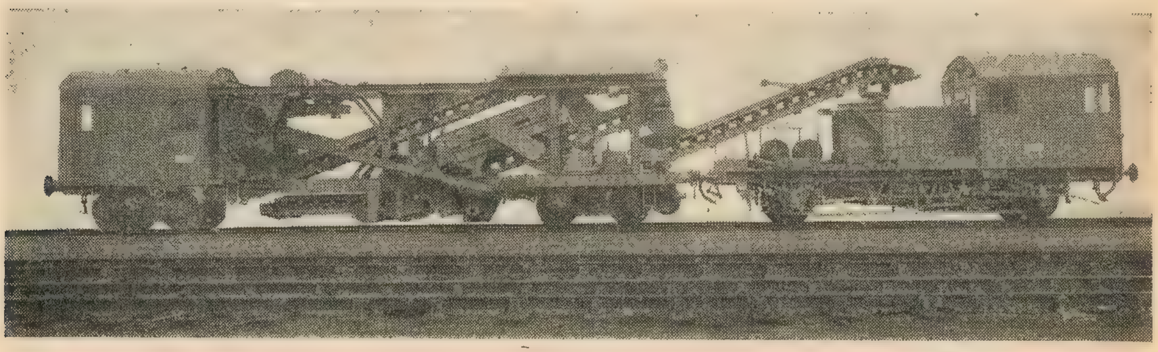
The photograph shows the Matisa machine in the travelling condition and with the chain troughs retracted.

Chertsey, Surrey. H. L. DENVER (Matisa Equipment Ltd).

MODEL SUBMARINE

SIR,—P. D. Brooke [Postbag, August 29] asks if a working model submarine has ever been made. Such a model has been constructed by German model makers.

In the early 1930s Gamages had a



The Matisa ballast cleaning machine shown in its travelling condition

Top picture shows the overhauled 78-year-old Kitson 4-6-0 with David Parsons leaning nonchalantly on the buffer beam. Below it are the two models which he is now busily constructing

fairly large tank in which clockwork, electric and other boats could be tested, and among the exhibits were some submarines, all about 9 to 12 in. long.

The assistant drew my attention to a model made in Germany, which was about 2 ft long, and in outside appearance was a perfect model of a U-boat. I asked him to demonstrate it but he said the tank was not long enough, but he assured me that it worked perfectly.

I finally paid the sum of 38s., and took it home. After dinner my son and I took it out to my large pond, which measures 35 ft × 45 ft. We proceeded to wind the model up and then placed it on the water. Off it went, submerged most realistically, hit the bottom and, after scraping along for a short distance, surfaced, also in realistic style. The submerging and the surfacing were done by vanes. There were two forward and two aft, and when they were depressed by the mechanism the vessel submerged, and when they elevated she came to the surface. With one winding up she did this six times.

I have been toying with the idea for some time past of building a submarine to work on this principle, especially as there are some marvellous small electric motors on the market which could be used for driving it.

With the German model, when it floated on the surface it was in diving trim, but if I built one I would like it to be able to run on the surface in surface trim, but then the problem arises of how to put it into diving trim.

Eastbourne, Sussex. V. B. HARRISON.

STROUDLEY'S ENGINES

SIR,—I feel that I cannot let C. M. Keiller's statement [" The Jubilee Compounds," September 5] regarding W. Stroudley's Brighton engines go unanswered. It is quite probable that the Gladstones would not have broken any records on the LNWR, but this fact is quite irrelevant since the art of a locomotive designer lies in his being able to produce engines capable of working efficiently—and economically—over those lines for which they are intended.

This Stroudley's engines did as, perhaps, no other designers have ever done, not only on the LBSCR but also north of the border.

As for " more leisurely Southern lines," Stroudley's Terriers made them anything but that when dealing with the peak hour suburban traffic. Moreover, some five of these engines at the Fratton shed are still in daily passenger service having been constantly at work since the 1870s !

No, sir ! Had Stroudley designed engines for the LNWR there is little doubt they would have handled its traffic just as competently as his LBSCR locomotives. But then, of course, Stroudley had no phobias regarding compounds to cloud his ability.

Worthing, Sussex. R. A. HOLDER.

THE OLD KITSON

SIR,—One of my photographs shows the old Kitson No 2269 built in 1879 for the old NC Railways now incorporated in the South African Railways. She has had several numbers and as No 26 she was on the first train into Pietermaritzburg in 1893 with urgent dispatches for the Governor.

She ran the 73 miles from Durban to Pietermaritzburg over a line of 1 in 30 grades and 300 ft radius curves with three loaded wagons, making three stops for water, at one of which she took coal, in 2 hours 18 minutes. The normal schedule was 4 hours 15 minutes.

Today the express over the new line does the run with electric locomotives of 4,000 h.p. in 2 hours 26 minutes, hauling 13 to 16 coaches. The altitude reached is 2,606 ft at Umleas Road, 50 miles from Durban.

I am building a model of the Kitson and also the SAR class 18 2-10-2 built in 1927 by Henschel. It is a three-cylinder of $114\frac{1}{2}$ tons (tender $72\frac{1}{2}$ tons) with 4 ft 9 in. coupled wheels. Tractive effort at 75 per cent is 53,650 lb.; boiler is 6 ft $3\frac{3}{4}$ in. inside diameter.

I am building a track of $2\frac{1}{2}$ in. and $3\frac{1}{2}$ in. round the grounds of my house and I will get a run of 270 ft. Unfortunately curves will be about 23 ft radius. One grade will be about 1 in 50, 20 ft long.

I am charge hand locomotive fitter on the ESC Roskervelle Loco Dept. We have just overhauled the old Kitson. She is now the oldest locomotive running in South Africa, being 78 years old.

Transvaal. DAVID H. W. PARSONS.

POSTBAG . . .

THE SAINTS

SIR,—J.N.M.'s excellent article on the GWR Saints [" Locos I Have Known," September 5] reveals some interesting facts on the performance of an express locomotive and on the power required to move a train at speed.

In this country it is customary only to quote tractive effort as an indication of performance. This is a pity because it is misleading, e.g., a shunting engine may have a higher TE than an express engine although the latter may be much the more powerful. TE may be an indication of a locomotive's ability to start a train from rest but it is no indication whatever of ability to move a train from A to B at scheduled speed. This is a question of horsepower and it is interesting to consider the Saint in J.N.M.'s article.

The Saint was designed to maintain a drawbar pull of some 4,500 lb. at a steady 70 m.p.h. This, incidentally, is about the resistance or drag of a 400 ton train at this speed, and rather more than half is due to air resistance, even at this moderate speed. Hence the scope for saving fuel by streamlining.

The Saint was, therefore, developing drawbar horsepower of $\frac{4{,}500 \times 70}{550} \times \frac{88}{60}$ = nearly 840 h.p. But the Saint had also its own rolling resistance to overcome, and this with the tender would amount to at least 1,250 lb. more. This absorbs a further 233 h.p. making the total power at the driving wheels about 1,075.

Frictional losses in the motion, valves, rings and stuffing boxes would be appreciable, say 10 per cent, which means that the two cylinders of a Saint could develop some 1,200 i.h.p. continuously.

Indicated horsepower of 1,200 corresponds to a mean effective pressure in the cylinders of 50 p.s.i. at 70 m.p.h. at which speed the driving wheels were making 292 r.p.m. If this was, indeed, obtained at 20-25 per cent cut-off those big piston valves must have provided very free breathing of the steam and I doubt whether the best slide-valve design would compare. This was a design of 50 years ago !

The figure for the TE is quoted as 20,530 lb. at 85 per cent boiler pressure. I am not sure how this was arrived at but, taking the worst case when one crank is on dead centre as one must with a two-cylinder design, the TE at 85 per cent boiler pressure works out at 19,250 lb.

Bromley. N. LAW.

HOT-AIR ENGINE . . .

Continued from page 538

not through the tubes. To this end we fit a very light steel disc round the plunger rod, with a small amount of end movement along the rod; the disc can bed into a recess in the plunger end (Fig. 10).

The air escapes from the disc valve *AA*, retained by the collar *B* on the rod and seating over the tube ends as shown, the valve tending to seat by its inertia.

PROPORTIONS OF THE PLUNGER

An important point in construction is the relative volumes swept out by the piston and plunger, which should be such that the terminal pressure at the power piston does not fall too low.

If the air expands to twice the volume it had when it was at its highest pressure, that is the most it should be allowed to do, since it only commences with two atmospheres and a third. The same proportion would obtain for every atmosphere of pressure, when cold, in a pressurised engine.

Though plungers of hemispherical end form are shown in these sketches, the streamlining effect is probably negligible, and would only be admissible in a long plunger for a long stroke, where the loss of volume due to the loss of " shoulders " is relatively less.

In a short stroke engine, say, with bore and stroke equal, the plunger would then presumably be almost cylindrical (see Fig. 10) because if it were spherical, with the same diameter as the main piston, it would not move enough air to feed the power end, since the sphere is only $\frac{2}{3}$ of the volume of the equivalent cylinder. Therefore, a spherical plunger would need to be slightly larger in diameter than the piston. If the single tube were initially used, the power cylinder could receive a liner.

CONTROL

In the case of atmospheric pressure working, a simple decompression valve opening communication with the outside air would damp out the pressure rise, and fall, reduce the power, and slow the engine down. It could be operated by hand or governor. The same applies to pressurised engines but communication could be opened to an exterior vessel, which, containing air at the same basic pressure (which would not take part in the heating cycle), would absorb a part of the rise and fall, without loss of the compressed charge.

It might happen that after a period of light running, the valve was closed to increase the power output at a moment when the pressure was at its maximum, thereby leaving, subsequently a rather reduced amount of air in the main chamber, so a small check valve could be fitted near the communication (to open inwards towards the main chamber) to allow the trapped air to return to the main chamber when the pressure in the latter dropped with expansion and cooling.

Reversing engines, with valves for this purpose, can employ the valves also as throttles.

For a single cylinder, with sleeve operated plunger as in Fig. 5, a system might be employed which would retard the plunger in relation to the piston, by reducing the angle between them to below 90 deg. by mounting the plunger crank, on a free sleeve on the shaft, controllable by flyweights and links. This would mean that the pressure build up would commence late, and would early be destroyed by the main piston passing dead-centre and expanding the air behind it.

The figure shows how the plunger crank (white) would delay in driving the air up into the hot end of the chamber, the power crank being moved the same amount towards top dead centre, in each case.

This, of course, is equivalent to retarding the ignition or injection in the i.c. engine. The retard would be facilitated by the engine speed, as the left-hand side of Fig. 11 will show.

Another system would be to reduce the plunger stroke, so making the amount of air heated during each cycle proportional to the load. This would, of course, be the most economical method.

As will be seen from Fig. 13, this again could be operated by flyweights but an alternative method is shown, which permits varying the throw of the crank by manual application of a brake (either a band, or a shoe, to the disc edge) while the motor is running, and thus causing the connecting-rods to pull the pin block and balance weight inwards against the compression springs. ■

CLUB NEWS

EDITED BY THE CLUBMAN

THIS should be a cosy autumn for Oxford and District SMEE, a society which believes in helping itself and, in consequence, is helped by others. What was once a disused hut is now the club headquarters.

After working hard to renovate and decorate the premises, which include a main room and two smaller rooms, the members celebrated the opening with an exhibition of their work. Among the exhibits were a miniature railway and a $3\frac{1}{2}$ in. tank locomotive which took two years to build and can carry six children along the track. One of the novelties was a tobacco-shredding machine.

Kindness of local firms

In a city where societies of every kind proliferate, the Oxford modellers enjoy the friendliness and practical help of local firms. Machinery and tools, when no longer wanted, are handed over gladly to the men who can use them. The initiative shown by the society itself, as in building a new headquarters, encourages this kind of practical goodwill, much to the benefit of the workshop.

Largely as a result of the rate increases, some clubs are now facing serious accommodation difficulties. One way of solving them is Robinson Crusoe's—or something like it.

GAUGE I LOCO

There is bound to be a demand for the new series on the construction of Newbury, *the simple 4-4-0 gauge I locomotive built by Martin Evans in the ME Workshop, about which J. N. Maskelyne writes this week.*

Starting next week, Evans will describe, step by step, how he built this water-tube, spirit-fired engine, which, though thoroughly workmanlike, can be attempted by newcomers to model engineering.

Make sure you get this new series by placing a firm order with your newsagent tonight, or by sending to Percival Marshall Ltd, 19-20 Noel Street, London, W1. A year's subscription by post costs 58s. 6d.

THE SECOND STEP

Earlier this year I mentioned that this page would be glad to bring together ship modellers in the Thames area of Windsor and Slough who would like to form a local club. W. E. Pryor replied from Windsor, and now C. Townsend, of 21 Bridge Road, Maidenhead, is offering to join forces with him. Mr Townsend is at present a member of **Victoria** club.

PORT PANORAMA

Meanwhile, in another part of England, **Bristol Ship Model Club** is planning an exhibition entitled "Ships in Miniature" at the Bristol Museum and Art Gallery. The show will run for quite a long period, from October 5 to October 26, and will feature a panorama of the Bristol docks with models of well-known vessels which visit the port. There are working and scenic models of all kinds.

LET TINY TIM LIVE!

When I last heard from secretary A. Balmforth (24 Thornton Lane, Bradford), the **West Riding SLS** was preparing for its annual social.

Taking a large room at the Guildford Hotel in Leeds on November 30, the society will devote half of it to an informal get-together and the other half to high tea. The rest of the time is to be occupied with a film show.

Replying to H. Lakeman of Cottingham, the editor of the society's bulletin expresses regret for the puzzling misprint in Mr Lakeman's article on the fairground engine *Try Again.* In the bulletin *Try Again* somehow appeared as *Tiny Tim* and it was by this name, of course, that the engine was introduced to MODEL ENGINEER readers when Vulcan quoted from the bulletin article.

I am now wondering if someone will build an engine and call it *Tiny Tim.* It's too good a name to die as a mere misprint!

TRIBUTE TO SECRETARY

L. M. R. Hiscocks has resigned as secretary of **Exeter and District MES** "owing to additional calls on his time from other sources." While his decision was greatly regretted, the committee had no choice but to appoint a successor.

H. Godfree Angel (Belmoor, Longdown, Exeter, Devon) undertook to carry on until the next annual meeting in February. Paying tribute to the former secretary, he writes: "Mr Hiscocks had been the secretary for many years and the society was fortunate in having one so suited for the job, for so long. He is an expert ship modeller and has received many awards and much admiration of his work at various exhibitions."

Let us hope that he will somehow find the time to continue with his beautiful ship models.

FRIENDLY RELATIONS

Secretary W. A. Camwell of the **Stephenson Locomotive Society, Midland Area,** is giving a film show to **Birmingham SME** at the White Horse on October 2. At the end of the month, on October 30, the society will hear a lecture by H. Chase of **Birmingham MRC.**

These occasions are characteristic of the friendly relations which exist between the men at Campbell Green and the enthusiasts in other clubs. Much the same kind of friendliness is also to be found in the society's liaison with local interests outside the strict periphery of model engineering. As examples we have a visit to Derby Works and Railway Museum on October 6 and a visit late next month to Johnson Matthey for a lecture on welding.

An excellent winter programme leads to "Genevieve" at the Crown Hotel on December 11. Some members probably saw "Genevieve" many moons ago—but this is a film which one enjoys even more the second time.

ME DIARY

October 18 Birmingham SMS "A Doctor Afloat," Dr Stanley Wood, Imperial Hotel, Temple Street, Birmingham, 7.30 p.m.
Rochdale SMEE general meeting, Lea Hall, 7.30 p.m.

October 19 Warrington MES track day, Earlstown near Warrington.
Chester show ends.
JIE paper, "Oil Additives," S. E. Holmes, 7 p.m.

October 20 MRCA Bath: National Championship, open: Bath Mini-Car Club, Drill Hall, Lower Bristol Road, Bath.

October 25 Thames Shiplovers film show by David R. MacGregor: *Sorlandet, Mayflower II,* Thames barge; Baltic Exchange, London, 6.30 p.m.

October 26 Scottish Model Engineering Exhibition. Christian Institute, 70 Bothwell Street, Glasgow, 10 a.m. to 10 p.m. (October 26-November 2, 11 a.m. to 10 p.m.).
Bristol SMC "Ships in Miniature," Bristol Museum and Art Gallery, last day.
Institution of Engineering Designers, visit to Huwood Mining Machinery Ltd., 9.30 a.m.

Model Engineer

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